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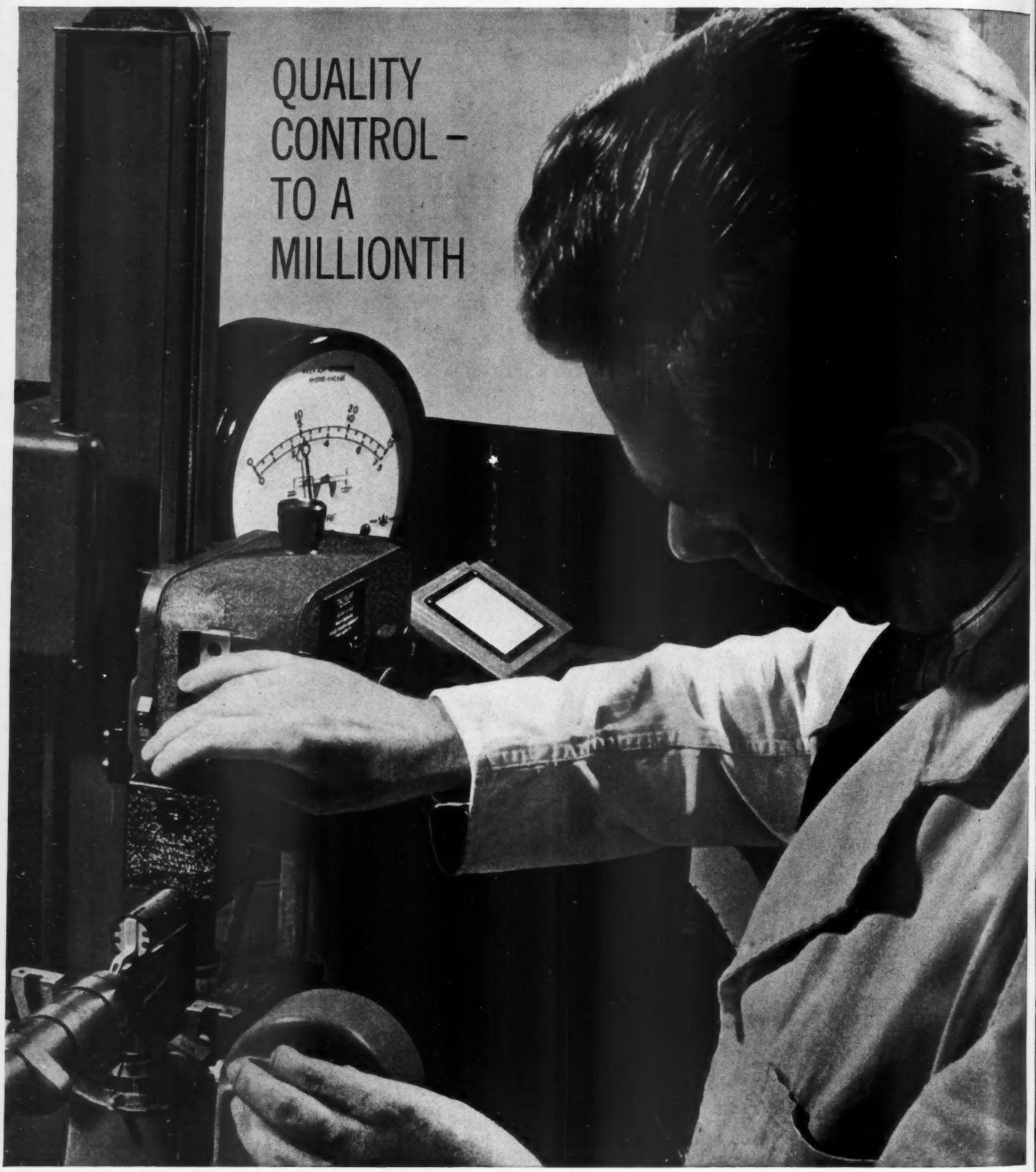

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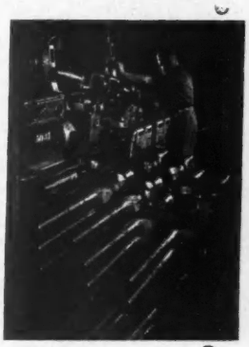

Cover Picture

Using an air hoist to load a four-throw crankshaft from a pallet into a pin-forming machine which forms two pins at a time.
(*Nurnberg photograph for* ENGINEERING)

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ENGINEERING Impact

of Dr. Beeching's Philosophy

In engineering terms, the most important of Dr. Beeching's five groups of studies for British Railways is the fourth: "studies to determine how the railway system of freight handling could best be modified to attract the maximum amount of remunerative traffic."

These studies could easily throw up proposals for radical modification of the normal equipment and rolling stock of the railways, and perhaps the introduction and more widespread use of the container system.

The new chairman of the British Transport Commission expects all these studies to be substantially completed within a year. He was asked by ENGINEERING who he would appoint to carry out the studies—members of British Railways' staffs or outside men? He replied that at the moment he intended to arrange for the studies to be done by people already on British Railways, though possibly later he would bring in a few from outside to assist them. This concept parallels his main policy to bring in "a sprinkling of men from outside with good ideas" to strengthen the top managerial levels of the Commission. On the one-off job of the studies he might, of course, use consultants, partly to get the job done as quickly as possible and partly to ensure a fresh, objective look at the railway's deep-seated troubles.

Dr. Beeching sees the modernization programme, which was started in 1955, as simply the means of keeping the system in a satisfactory state. Improvement in receipts, if it comes, is more likely to "result very largely from changes made in the mode of operation of the system."

Looking many years ahead, the most important revelation to come out of Dr. Beeching's first Press conference was his statement that although a continuing life of many years seems to be assured for most of the railway system, its "ultimate replacement" may be planned in the meanwhile.

Inadequate Highways and the Road to Stagnation

The mysterious staisfaction of Government spokesmen at the dawdling pace of road reconstruction in Britain is not merely odd, it has serious dangers for a manufacturing nation dependent for its livelihood upon the competitiveness of its industries.

At the annual meeting of the British Road Federation, Lord Derwent, the BRF chairman, pointed out the strange development by which the five major road projects first announced in 1956, and supposed to be the start of a fine system of new roads, have become the whole network. The five major projects, excellent though scarcely sufficient in themselves, cannot be a corrective to that part in the United Kingdom's slowness to increase the national output which is due to the difficulty of shifting materials, components and finished products from place to place.

The British Road Federation's report, entitled Government Road Programme, recalls how, back in 1956, Mr. Harold Watkinson, the then Minister of Transport, had said that the five major road projects were all major traffic arteries to be completed as quickly as possible. They would be the beginning of a new skeleton of a new road structure to be expanded and developed.

Odd Transformation

From this grand view, which appeared to be based on a reasonable awareness of a great new system and not just five main routes, official pronouncements have moved round to the speech, last July, of the present Minister of Transport who claimed in the House of Commons that within five years city to city problems will have been solved. "By the middle 1960's these principal routes will be second to none and fully adequate for the traffic for many years to come."

Thus the first priorities of 1956 may be "substantially" complete ten years later. And as to their being fully adequate for years to come, the history of traffic engineering is full of examples of traffic calculations being overwhelmed by unexpected growth in demand almost before the rain has marked the concrete.

Lord Derwent's conclusion on the necessary remedies is that Government spending on the roads must be doubled before the point of no return is reached.

On trunk road modernization, on the work on classified roads in County Council areas, and on road works in towns and cities, the British Road Federation has done its sums and decided that in every aspect the expenditure is only about half of what is wanted.

The impression is still given in official speeches from time to time that modern roads are something a prosperous nation must carefully consider along with many other priorities, a kind of Welfare Service to take its place with pensions and the upkeep of prisons. The simple truth is that the means of communication and transport are part of the equipment for becoming prosperous. The degree to which the nations of Western Europe have out-distanced the United Kingdom in modern road building is great enough to be all too easily accepted. There is no reason to doubt that the possession of a first class road system in their industrial areas has helped the European Common Market states to make their national product accelerate at runaway speed.

For years road works have held the traditional place for some economists as one of the fallback measures, a resort for the last ditch, when work must be created to stave off the worst effects of a slump. Times have now put this dogma into reverse. With the productivity of powerful competitor nations going swiftly ahead a major manufacturing country that neglects its roads must fall behind in the race. It is necessary to give up drifting and take the decisions now that would mean when the Big Five (from M1 and the Ross Spur to the Medway Motorway) are complete a very large volume of work would be going on other tunk routes up and down Britain.

Somehow a road system equal to that of our industrial competitors has to be brought down out of the clouds of weekend speeches and made reality.

of Electricity 1960—2000

Of all the ways of considering the likeliest advance in electricity demand of the future the two most often met are those that predict a doubling of consumption by 1970 and subsequent advance at the same rate, and the alternative belief that if there is an installed capacity of 100,000 MW by 1985 followed by a steady 3 per cent annual increase from then on, the plant installed by the end of the century will be well over 150,000 MW. The proposition of doubled capacity every ten years would, of course, lift installed capacity to the splendid height of more than 400,000 MW.

Even if it is accepted that the reality may lie somewhere between these poles the difficulties of the heavy electrical interests in plotting the best courses for the future are obvious enough. But the total future demand is not their sharpest worry.

In his presidential address at the Eastbourne British Electrical Power Convention this week, Sir John Pickles, looked ahead to the time when there may be direct conversion from heat to electricity without need of an intervening steam cycle. The three focal points of attention to which Sir John pointed were the thermionic, the thermoelectric and the magnetohydrodynamic (MHD) methods of generation.

Thermionic and thermoelectric methods the President was ready to find "highly speculative." With the fuel cell, he bundled them off into the next century.

The magnetohydrodynamic prospect, direct generation by passing hot gas through a magnetic field, was judged to be more promising. The possibility presented here is the eventual superseding of the boiler, turbine and alternator. When the violent pace of the revolution in electricity, and brought about by it, since 1920 are recalled it is certainly possible to conjecture that progress in MHD generation may develop into a series of changes as serious for the heavy electrical industry as they appear promising for the bill-paying consumer.

Hoping for a Customer in a Clyde Shipyard

The decision of a Clydeside shipyard to go ahead and build a ship although no order has been placed for the vessel is as clear an indication as possible of the difficulties in which shipyards are increasingly finding themselves.

The yard taking this striking step, one that has spent £3 million on modernization since the war, is able to build ships of up to 45,000 tons. In practice the speculative ship to be laid down will be a high-quality general cargo vessel of between 12,000 and 14,000 tons. The yard is working on its two last orders, one of the ships having been launched.

The drastic effects on a shipyard of disbanding its labour force are plain enough. In addition to the effect on the men and their families there is the certainty that when the next order is brought in, time will be lost recruiting, questions of training could arise, and certainly the smooth teamwork, co-ordinated in years of shared experience would not at first be all that it was.

For the employer there is also the consideration that in times of full employment, though not of easy housing conditions, numbers of men would probably decide to make for the Midlands and the South-East in search of employment outside the uncertain world of building ships at a time when more than one river is still a sad shipping-park.

The firm building the new ship have approached their men to endeavour to keep the cost down and the quality up. Creating an asset worth more than a million pounds before finding the buyer is one of those extreme remedies which may put many of the cards in the hands of the purchaser when he comes to negotiate the sale. But keeping the labour force of a shipyard together is an objective worth striving for as long as faith and hope hold out. In the meantime skill and experience is not being allowed to have its fine edges rusted away for lack of use.

Engineering Techniques and Human Problems

A common course for all engineering undergraduates in their first and second years, dividing into mechanical, electrical, civil, chemical and aeronautical only in the third year, and with specialization within these main branches held over to the post-graduate stage was favoured by Sir Willis Jackson, Research and Education Director of Associated Electrical Industries (Manchester), in the 1961 Viscount Nuffield paper, "Some Human Aspects of Engineering Progress," given at Bristol last Wednesday to the Institution of Production Engineers.

With the growing interdependence of all the branches of engineering the young engineer, who would have to be something of a specialist in the early stages of his career, would become a first class specialist only if he were knowledgeable about events in other specialities impinging upon his own field of work.

Sir Willis pointed to one of the dangers of too early specialization. That the young engineer tries to find the solution of his technical problems in terms of his particular speciality. For example, the electrical engineering graduate who in his last year has concentrated upon electronics will almost inevitably seek an electronic solution to a problem of automatic control, even though it may be better engineering to use hydraulic or pneumatic methods.

Hoping that the production engineers would not press for an undergraduate sub-division devoted to their specialism, Sir Willis saw good reasons why the importance and potentialities of the production side should be drawn to the attention of the undergraduate engineer.

The student should learn that exclusive devotion to a scientific and technical discipline will not give him all he needs in life. Since modern engineering is an exercise in team work the considerable scientific and technical knowledge required for success did not themselves guarantee it. Interest in, and ability to resolve, human problems becomes increasingly important to all engineers.

Using Electro-Hydraulic Servo Controls

Miniature high-performance servo-valves designed for aircraft and guided weapon projects are now finding wide use in control applications generally.

IN THE United States, 20,000 miniature high-performance servo-valves are being produced each year by Moog-Servo Controls Incorporated. These valves are associated with most of the major aircraft and rocket projects in the USA. Initially designed and developed for advanced airborne applications, they are also being increasingly used in the fields of general industry.

Two years ago, Dowty Rotol Limited, of Cheltenham, Gloucester, through their Servo-Valve Division, became the European and British Commonwealth Licencees for Moog's range, and they are similarly mass producing them and supplying them for aircraft and guided weapon projects. At the same time, Dowty are turning their attention to the very wide variety of control applications arising in industry, particularly in the field of automation. One UK company has applied the Dowty-Moog servo-valve to seven different machine tool control systems and is now putting at least three of these systems into quantity production.

Dowty-Moog Servo-Valve

Basically, the function of the valve is to receive an electrical signal from any source and convert this signal into an accurately controlled hydraulic output. It is the key to automation, the link between the black box which does the thinking and the hydraulic muscles which do the work. In conventional machine tool usage, the electrical signal originates from magnetic tape or punched cards on which a series of operations, in two or three dimensions, have been recorded. The output from the tape is fed through an amplifier to the valve, which is usually mounted either directly on to an actuator or a hydraulic motor.

In this way, a machining programme can be transmitted with very great accuracy to the cutting head of a machine tool. One of many typical examples is the Hayes/Ferranti "Tape-master," a precision vertical milling machine which will give a continuous machining time of 2 hrs 40 mins for one reel of magnetic tape. Many similar applications control either the positioning of the tool itself, or the material being processed.

A standard valve is little bigger than two matchboxes (see Fig. 1) and weighs less than ¾ lb, yet, providing the associated equipment has been properly matched to the valve, machining accuracies of 0·0001 in can and are being achieved. In the flat-band region, at frequencies up to 150 c/s the valve can handle 17·5 output hp; and achieve power gains of more than 300,000 : 1. Low flow units are being supplied which have a phase lag of less than 90° at 150 c/s. Time constants for the Series 21 and 22 valves are in the order of 2 millisecs. At a recent exhibition, Dowty Rotol displayed a valve operating the diaphragm of a loudspeaker at frequencies up to 1,500 c/s per sec—thereby reproducing both music and human speech. Performance characteristics for one of the valves is given in Fig. 2.

The valves consist of a polarised electrical force motor, and two stages of hydraulic power amplification. The double nozzle—flapper first stage controls the differential pressure applied to the second stage spool. The spool is of a conventional four-way design, and is spring-centered. Output flow from the valve, at a fixed pressure drop, is proportional to spool displacement.

As a signal is applied to the motor, a force is developed upon the flapper, causing it to pivot and to move between the nozzles. This motion causes one orifice to open as the other closes, resulting in a differential pressure between the nozzle chambers. The pressure difference, acting upon the nozzle projected areas, results in a feedback force upon the flapper to balance the motor force. The pressure differential also acts upon the second stage spool, resulting in a displacement. Hence the hydraulic output is directly proportional to the electrical input signal.

The aim is to supply the servo-valve units to meet each customer's particular requirements so long as those fall within the general operating limits of the valve. This means that the valves can be driven either by transistors or by conventional valve amplifiers, with hydraulic output flows ranging from zero up to 10 gallons per min. Operating pressures are from 50 lb to 4,000 lb per sq. in.

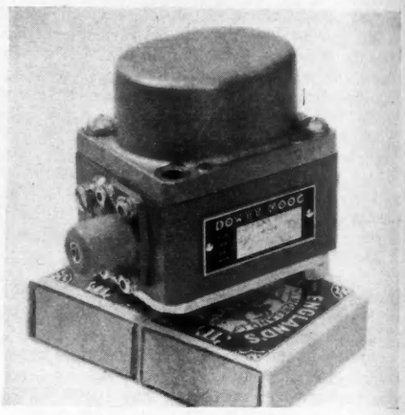
Control Principles

It will be appreciated that the accuracy of a high precision system cannot be greater than the accuracy of any one component. The performance of a servo-valve must accordingly be considered in the context of the whole servo loop such as shown in Fig. 3.

An electro-hydraulic control system, using feedback from the controlled system output, is often the only means of meeting a set of difficult performance requirements. In general, this type of system is considered wherever a high-power control action is required, in response to a low level electrical signal, to obtain a degree of automation. The input or command signal may be delivered from a distant point to provide remote control or the signal may be generated nearby. Very fast response, and ability to resolve the minute signals encountered in precise positioning, can now be achieved by electro-hydraulic control.

The controlled output, such as a position or force, is continuously compared with an electrical voltage corresponding to the desired output in a feedback control system using an electro-hydraulic drive. The output is measured electrically with an instrument which generates an electrical signal. Any difference between the two electrical signals being compared is known as the "error signal." This error signal is then amplified and used as an input to the servo-valve

Fig. 1 A series 21 Dowty-Moog servo-valve. In the flat response region, valves of this type can achieve power amplifications in the order of 1,400,000.



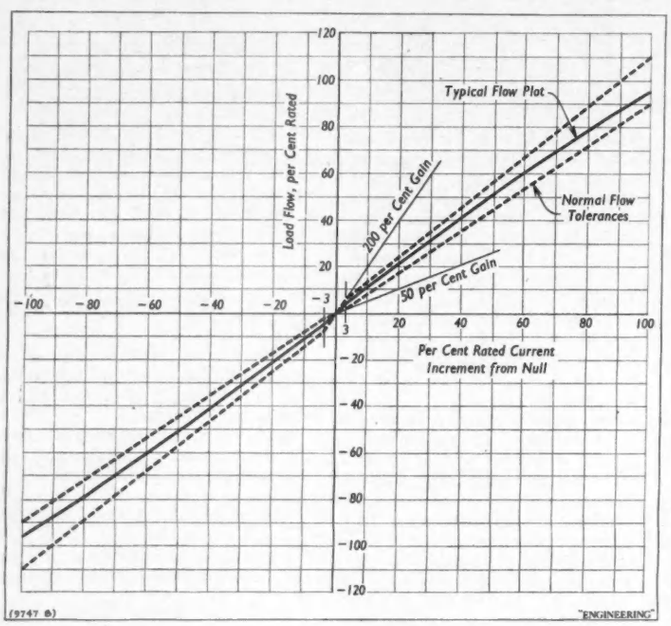
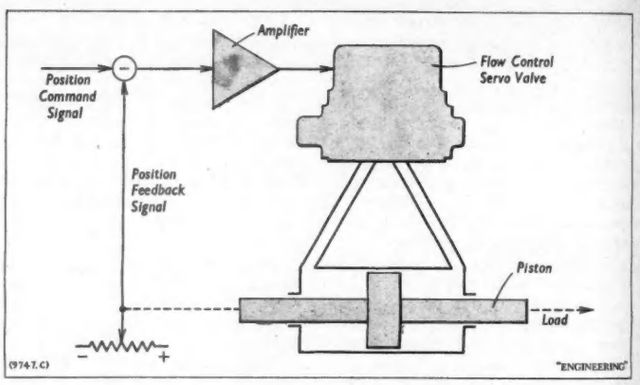


Fig. 2 (left) Performance characteristics of a Dowty-Moog low-flow control servo-valve. (Normal flow gain tolerance.)

Fig. 3 (below) Typical simple servo loop.



which, in turn, will change the output in an attempt to reduce the error signal to zero.

The polarity and magnitude of the error signal determine the flow direction and the rate of flow respectively. As the control system continuously attempts to balance the feedback signal against the command input signal, errors are kept very small.

A typical electro-hydraulic control system consists of an electronic amplifier, an actuator such as a motor or cylinder attached to a load, a feedback transducer or transducers, and the servo-valve. The system, of course, must be externally supplied with electrical energy for the amplifier and transducers and with hydraulic power for distribution by the servo-valve. The overall accuracy of such systems is mainly dependent upon the accuracy of the feedback transducer and the resolution ability of the servo-valve. These therefore are the two critical components of a control system.

Other factors can also influence the accuracy of the system. The rate of corrective action as a function of the error signal magnitude, which is associated with the system "gain," will influence the accuracy while the output is changing. The system gain will also influence static accuracy if the actuator must overcome high friction in order to move. High gains are required to reduce errors to a minimum. Changes in environment conditions applied to the control system, such as temperature and supply pressure, tend to influence accuracy but these influences have only a very minor effect on performance.

In addition to static performance, dynamic performance such as stability and response must also be considered. In order to satisfy simultaneously all requirements on a control system, it is frequently required to use more than one feedback signal and/or electrical compensation network. If accurate positioning and velocities are required, both position and velocity feedback must be provided. In some systems acceleration feedback is helpful. The general subject of servo stability and dynamic response cannot be covered in this general outline.

Applications

The basic applications of electro-hydraulic controls to industry may be broadly subdivided into the categories of position control, velocity control and force control. Sub-divisions within each category may be made in accordance with the type of command signal. The following paragraphs briefly outline a number of applications for such systems.

1. Position Control Systems:—These are the most common applications for servo-valves in industry. Some typical applications have already been suggested, such as positioning the cutting head on a machine tool, controlling the edge of materials being processed including metal, fabric, glass or paper, tilt control on road graders and hydraulic press brakes, also stem positioning of process control valves. Two types of drives are in common use in association with a servo-valve for linear positioning. The simplest is an actuator attached directly to the device to be positioned. The other is a hydraulic motor and gear train combination which positions the load by rotating a lead screw. The latter method is used when the drive stiffness must be kept as high as possible.

The accuracies required for positioning on some machine tools exceed the ability of any single feedback transducer. In such cases, multiple transducers must be used, each covering successively smaller ranges. Multi-speed synchros are often used for this type of application (several synchros at a gear ratio with respect to one another). Alternative approaches use potentiometers or linear transducers for coarse control and an accurate inductive device for fine control. The transducers mentioned above are all of an analogue type as ac or dc voltages proportional to displacements are obtained.

2. Fixed Position Controls:—A fixed position control or set-point control maintains the output position at a constant value despite load disturbances. A tilt control on a hydraulic press brake is a typical example of a fixed-input control system. The ability to maintain accuracy in the presence of load disturbances is the most important performance consideration.

3. Point-to-Point Position Control:—A familiar example of point-to-point control is found in the numerous positioning systems associated with many numerical machine tool controls. Point-to-point positioning is used for such operations as drilling, boring, milling, honing and tapping. Two positioning systems are employed to achieve point positioning in any one plane. In general, the path from point-to-point is unimportant. Accuracy of positioning, ability to hold the position and minimum lost time between points are of prime importance.

4. Variable Position Control:—In such control systems, the output is required to follow a command input which changes in a continuous manner. Certain numerically controlled machine tools are capable of contouring and require one or more electro-hydraulic servos to follow a desired path. Electro-hydraulic tracer control systems, which are in use on machine tools, also fall into the variable-position control category. The position of an input template and the output position are compared at the template by an electrical position transducer known as a tracing head. A position error results in a deflection of the tracing head to establish an error signal.

5. Velocity Control Systems:—Velocity or feed control systems are similar in configuration to a position control system except that a velocity transducer or tachometer is used in place of a position transducer for the primary feedback. In certain instances, it is possible to omit the feedback transducer and control speed in a simple open-loop manner with a flow control valve.

6. Constant Speed Control:—A common use for electro-hydraulics is to maintain a constant output speed in a drive which is subjected to a variable input speed. Known as constant-speed drives, such systems are typically used for powering ac generators where precise control of frequency is needed. Similar applications are found on steam turbines where it is necessary to position throttle valves in order to maintain constant speed in the presence of sharp load changes. Another application is in winding controls where it is desired to keep the approach velocity of a material constant by adjusting the drive spool speed as the effective diameter changes.

7. Feed Rate Control:—Certain applications on machine tools require that the feed rate be varied to compensate for changing diameter on a turning operation. The changes in feed rate may be programmed in accordance with time, but are more often related to position or reaction force on a tool.

8. Force Control Systems:—Electro-hydraulic control systems may also be used for applying a precisely controlled variable force or torque to a load or test specimen. High accuracy systems utilise force or torque feedback from the output. Sometimes the use of a pressure control valve makes it possible to create a simple open-loop if desired.

9. Tension Control Systems:—Electro-hydraulic force control systems are commonly used for maintaining a constant tension in sheet metal, paper or textile goods subject to a rolling or winding operation. Such systems are also ideally suited to the testing of tensile test specimens where it is desired to maintain a constant force regardless of the elongation of the material.

10. Programmed Force Control:—Another application for electro-hydraulic force controls occurs in the testing of structural elements. It is possible to duplicate complex loading patterns under controlled conditions to obtain valuable design information.

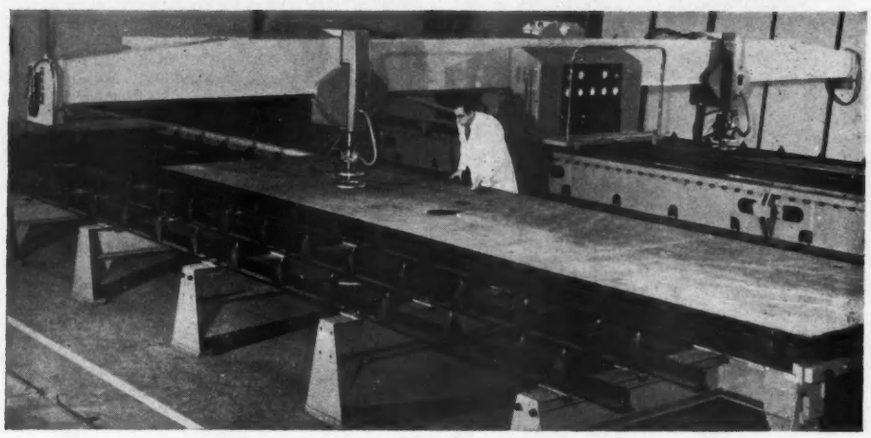


Fig. 4 Two servo-valves are used in the automatic control mechanism of this computer controlled flame-cutting machine developed by British Oxygen Company Limited in conjunction with Ferranti.

Conclusion

First call on the Dowty-Moog valve has been for units and complete systems to meet the requirements of missile and high-performance aircraft projects. There has, however, been a steadily increasing demand from other industries, faced with new mechanisation problems, for which these high-accuracy servo-valves are frequently ideally suited.

The foregoing suggest only a few of the categories of control system for which this versatile type of servo-valve is being increasingly used. Another field of rapidly increasing potential is that of vibrators—the motor car and aircraft world in particular employ them to simulate rough driving and turbulent flying conditions respectively; yet a further use is in the timed control of extruded metals and plastics.

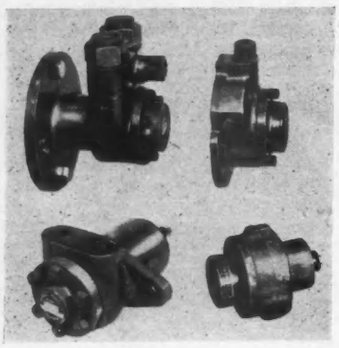
These are types of application which Dowty Rotol anticipate will be required in growing numbers as many systems which up to now have been considered as development projects start to turn-over to quantity production. In addition there are a number of unusual and specialist uses—individual problems for which these units have found original and efficient solutions.

Recent examples include simulating muscle impulses in a physiology laboratory, noise level testing equipment, and vibrating canal dams under water to monitor their strength under artificial flood conditions. One enthusiastic enquirer at a recent exhibition was considering a system to vibrate the floor of his large public dance hall in thythm with the band. Further proof, if any is needed, of the rapidly widening horizons of modern industrial hydraulics.

Pump for Integrated Installation

The problems of pumping engineers are numerous and vary from the nature of the liquid to be handled to the size, shape and physical limitations of the space in which the pump is to be installed. Recently the trend has been towards integrated unit construction.

Mono Pumps have introduced the Menrow pump which can readily be adapted to fit into an integrated unit for things such as oil burners, machine tools and refrigerating machinery. It does not possess the same versatility as the Mono pump in handling such a wide variety of



Menrow pump installed in integral units.

fluids, since its use is confined to non-abrasive fluids containing some degree of lubrication. The pumping mechanism can, however, be contained within a small compass and in relation to its size its capacity is high. A 100 gal per hr pump can be made as small as 4 in by 3 in diameter.

It is a positive displacement pump with a suction lift of 25 ft. The basic pumping unit can be arranged so that flow can be in one direction with fixed rotation, in one direction irrespective of pump rotation or as a reversible type for direction of flow towards either of the two ports. The suction and delivery can be arranged vertically, horizontally, opposed or at right angles, and it will operate efficiently at any mounting angle. The range is from 35 to 4,800 gal per hr with pressures up to 650 lb per sq. in.

Mono Pumps Limited, Mono House, Sekforde Street, Clerkenwell Green, London EC1.

Studies for Supersonic Airliners

For five years, feasibility and design studies have been going on at the Royal Aircraft Establishment at Farnborough on a supersonic airliner. Professor M. J. Lighthill, FRS, director of RAE, said at the recent Open Day that he was confident Britain could produce an aircraft which could cross the Atlantic in three hours at a cost close to those of the current jet airliners; the optimum speed appeared to be around Mach 2·2.

British interests lay in developing a long range transport while the French are more concerned in the medium range aircraft following no doubt on their success with the Caravelle. There are great hopes of collaboration with the French in the supersonic field.

Among many exhibits at the show, two were fairly representative of studies being conducted in supersonic aircraft. A model was displayed which was typical of the basic shape one could expect such an aircraft to have. It was built to investigate the stability characteristics of a design appropriate to a supersonic transport aircraft. This model is released from its boost rocket at Mach 2·5. During the subsequent coasting flight it is given a sudden disturbance by means of small impulse rockets mounted within the wing. Instruments carried in the model measure the response to these disturbances and from the measurements the dynamic stability characteristics are evaluated. This model is not recoverable, all the data being telemetered back to earth.

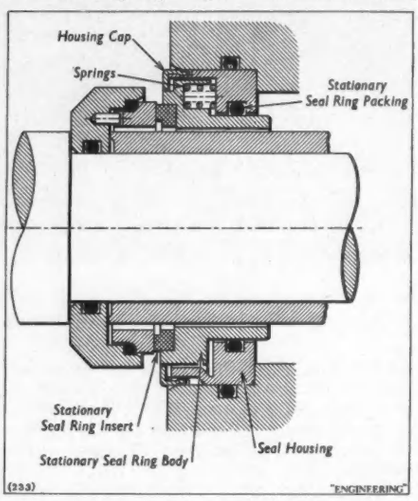
Other models of supersonic aircraft have been built to study the behaviour of such aircraft at low speeds—a real problem. These models are towed behind aircraft and the one displayed was of the Handley Page 115. It is built to ¼ scale and has so far made two flights.

A Compact Mechanical Seal

For high speed shaft sealing applications where axial space is at a premium, a new mechanical seal has been developed by Flexibox.

Known as type DD, the seal can cope with peripheral speeds of up to 15,000 ft per min, pressures up to 1,000 lb per sq. in and temperatures up to 500° F. All the components are replaceable and worn parts can either be replaced completely or reconditioned without destroying the whole seal. A close tolerance can be specified for the overall length.

The DD is a face-type balanced mechanical seal of multi-spring design. It consists essentially



For use where axial space is at a premium.

of a housing which carries a resiliently mounted stationary rubbing face assembly consisting of a body insert and resilient packing. A number of small springs arranged around the flange of the stationary seal ring body provide the face loading. This ensures close control and uniform application of the face contact pressure.

Three versions of the seal are available: O ring fitted, chevron packed and reversed balanced. Each of these types is available in two ranges of axial tolerance and three face loadings. The standard range covers shaft sizes from ¼ in to 8 in but larger diameters can be made.

Among the applications which the makers give are: aircraft fuel pumps, gas-turbine main shaft bearings, air and gas blowers and hydraulic pumps and motors.

Flexibox Limited, Nash Road, Trafford Park, Manchester 17.

Plough for Armoured Flexible Conveyor

A device for ploughing coal off an armoured conveyor developed at the NCB's Central Engineering Establishment is now in use in an East Midlands colliery.

It comprises a conveyor pan with a shaped hole in its deck plate—which allows the small fractions of coal to fall through on to a receiving conveyor—and a curved steel sheet obliquely mounted across the pan so that large coal is ploughed off. Part of the top chain race of the pan is cut away at each side, forming slots in which the plough is accommodated.

Square bars are welded on the underside of the bottom chain race, one on each race along the length of the pan to ensure that the bottom chain of the conveyor is raised clear of a stage loader across which it is laid, and to provide clearance for bent flights. The plates welded along its side stiffen the pan.

Using this device allows an armoured conveyor to be laid across a stage loader and the travel of the cutter loader is not then restricted by the armoured face conveyor head and ramp pan. It also allows the stable for the cutter loader to be shorter.

National Coal Board, Hobart House, Grosvenor Place, London SW1.

New Metropolitan Rolling Stock

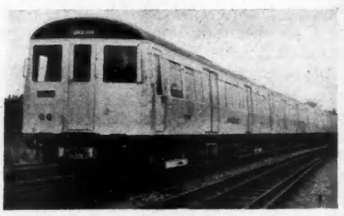
London Transport has just put into service the first of the replacement stock for the Metropolitan Line. Complete replacement will be effected over the next two years.

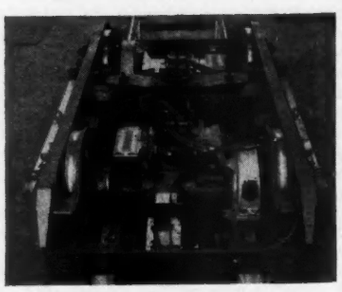
The new rolling stock is of completely fresh design specially evolved to meet the varying demands of the Metropolitan Line with its short-section high-intensity in-town services as well as those to the wider spaced stations outside Central London.

The cars will run in four-car units, two units being brought together in the rush hour. Each unit consists of a driving motor car, two intermediate trailers and another driving motor car. The bodies of the cars, built by Cravens Limited, are of aluminium alloy, unpainted, and are mounted on bogies which are built up of welded sub-units stress relieved before riveting.

Rubber units are used for primary and secondary suspension, the axlebox springs being of the rubber bonded chevron type housed in cast steel yokes provided with means for adjusting the frame height.

The bodies incorporate a number of features new to London Transport rolling stock. Construction of the body and underframe is in light alloy except that headstocks and underframe bolsters and their connecting longitudes are welded steel fabrications. While the longitudinal





(*Above*) *One of the 8-car trains and* (*below*) *one of the two-motor bogies.*

members are extrusions, crossbars between the bolsters are combined aluminium castings and extruded ties.

Each of the motor cars is fitted with a Wedglock automatic coupler to provide for reversibility of units. To allow for this, most of the train wires have to be duplicated at the coupler face.

Plain Words

By Capricorn

TECHNICAL progress, when it infringes on the human personality or human dignity, is resisted tooth and nail. I know; I'm pretty recalcitrant myself. Yet ought we not to venture into these forbidden territories—if only to explore?

Prejudice about machines is a strange and subtle thing. The Luddites smashed the early looms and steam-driven engines of the Industrial Revolution because they thought they threatened workers with unemployment. Not very far removed from this attitude has been the reaction of many people in recent years to automation. Many who should know better have looked askance at the computer, because they have suspected that here was a device for taking the place of the human brain. Cybernetics studies have had a similar reception.

The latest technical idea to bring forth suspicion, mockery and ignorance has been the teaching machine. The name is against it, of course. It reminds one of a praying machine from Tibet. Yet the idea of a teaching machine has much to recommend it in an age when there is great need of more—and let us face it, better—teaching staff.

The teaching machine (which incidentally is taken seriously enough at such places as Harvard University) has never been put forward as teaching anything itself. The machine requires a programme, just as a computer does. It offers students quick answers (though to know the answers isn't everything in education); and it can more easily control the students' progress than a book. You cannot skip the pages of a machine. It is in fact a mechanical tutor and has to be controlled by a human teacher. It also gives a record of the students' progress.

The idea of using a machine to help educate the young is unlikely to appeal to many in this country, nor will it be readily accepted in academic circles. A machine cannot inspire in the way a good human tutor can. On the other hand I have encountered, as no doubt have many others, some abominable tutoring. However you may have reacted to the recent uproar at Oxford when lectures were treated as legitimate material for public criticism and undergraduates expressed in print some candid views about their teachers, the incident is a straw in the wind. Teachers, in spite of the wage increase, are likely to remain in short supply, but we have to find an answer.

Let us therefore use what mechanical aids we can. As I argued some weeks ago, the more we can relegate to the routine, the subconscious and the automatic, the more time and energy we shall have to spare for the tricky or creative—and this is likewise true of teaching. Mind you, I too have my misgivings. I'm not quite ready yet to put my children in the hands of automata. And I view with even greater apprehension the thought of putting automata in the hands of my child. Perhaps I am at heart a present-day Luddite.

Letters to the Editor

National Use of Technical Information

SIR, I read with great interest the letter by Mr. B. T. Stern entitled "National Use of Technical Information" (ENGNG., 12 May, '61, p. 653).

I agree with Mr. Stern's statement that "Much of the writing on this subject has been 'preaching to the converted'," although not altogether with his reason for saying so. To my mind, the real reason is that most of it has been published in journals read almost exclusively by librarians and other information workers. Although so much has been written, to the extent that it is very difficult to find anything original to say, scientists, engineers and managements, to whom the efficient use of documented information is of prime importance and who need to be made aware of the best ways of ensuring this, very seldom see these enlightening articles.

It is possible that some firms believed that they were trying something new by setting up information services staffed by technically-trained personnel. Had the relevant literature been studied beforehand they would have seen that some organizations have been running similar services for years, even decades in some cases.[1] Also, they would have become aware of the problems involved before having to meet them and, hence, have been more sure of avoiding pitfalls. But, as stated, the literature never came their way. It is to be hoped that more authorities will now follow Mr. Stern's lead in putting matters right.

SCIENTIST OR LIBRARIAN?

Even so, there is potential danger here. One of the biggest controversies in the library profession during the last 20 years and more has raged over the question "who makes the better technical information officer, a librarian or a scientist?" Should the battle now be spread to the pages of ENGINEERING it would indeed be unfortunate. It would only tend to bring the library profession into disrepute in the eyes of engineers and harm the cause of librarians in industry, especially as the question is merely one of terminology, which the engineer would be quick to realize. It is this type of argument that does need to be kept to the library journals.

However, before this feud reopens, perhaps I could be allowed to explain the position for the benefit of the readers of ENGINEERING, being familiar with most of the important literature and having some knowledge of several technical libraries.

There appears to have been considerable confusion when there need not have been, even among the acknowledged experts. First of all, there are those who regard the terms "librarian" and "information officer" as synonymous. In 1945, Mr. A. B. Agard Evans[2] spoke of the "elementary but fundamental error in trying to distinguish between a special librarian and an information or intelligence officer. They were precisely the same animal, whatever the local term." More recently, Mr. D. J. Foskett[3] has written "... the profession of librarian and information officer is one" (p. 123) ... "since information officers (in the context referred to in this book, at any rate) administer libraries" (p. 124).

However, at a particular large United Kingdom research establishment, there are ten scientifically-trained information officers, none of whom can be said to administer a library since there are 24 other people paid to do just that! It is interesting to note, though, that all 34, together with the associated clerical staff and a section of translators, are responsible to a single head, styled "librarian," a person with a science degree and an additional scientific professional qualification but no library qualifications.

For another similar example; the "librarian" at a well-known chemical works has technical qualifications and laboratory experience but has had no previous library training or experience. Again, this person is in charge of people possessing the distinctions F.L.A. and A.L.A. (Fellow and Associate, respectively, of the Library Association), in addition to clerical staff and eight technically qualified "abstractors." Besides writing abstracts, the duties of the latter personnel include indexing, searching and the production of bibliographies and bulletins.

Then there is the "Farradane school." In a hard hitting article on the future of information work[4], one may read "... the information officer must have largely the same sphere of knowledge and outlook (as the researcher), and so must be an information *scientist*. Few of the essential tasks of an information scientist have affinities with librarianship, and newer developments of information work are still less related." Foskett[3] describes the situation well when he refers to "... the well-known thesis of Farradane, that the information scientist is not a librarian but the particular member of a research group who uses the literature on behalf of the others ..." This is the current practice at my own organization.

INFORMATION OFFICER

There is yet another point of view, expressed ten years ago by Mr. E. N. Simons.[5] Basically he agreed with the "separatist" viewpoint, saying, "The information officer, then, is a man in either a large or small organization whose fundamental job is not to keep a library of books, but to provide quickly and accurately such information as is required by any members of the firm, as a help in the carrying out of his professional duties." However, the separation envisaged is not so complete as in the previous case. He goes on to say "the information officer need not be a librarian ... if he is doing his job properly he should have little time in which to run an efficient library, though it should, at all events, be under his direct supervision. He should, in my view, have control of the librarian as regards discipline, total expenditure, engagement of staff, etc., and of all other incidental services."

Such is the confusion! And now to unravel it.

It is patently obvious that the matter of real importance is the quality of the personnel carrying out the information work, not what they are called. For instance, in one organization there may be a library supervisor responsible to a chief information officer. In another, the same person with the same qualifications doing the same work would be an assistant librarian responsible to a librarian. This latter terminology seems to have found most favour in general. (See reference 6 and the two examples quoted earlier.)

Neither does it greatly matter how the information work is organized, provided it is carried out efficiently and the particular system employed fits local conditions. To the user it is immaterial whether the information service is part of the library or whether the library is part of the information service or whether the two are completely separate, so long as he knows where to address his inquiries and knows that he will be informed of any important new data relevant to his work, without having to ask for it.

DOCUMENTS VERSUS DATA

On the other hand, it is of great concern to the user that the people answering his inquiries and keeping him informed are competent and adequate to the task. With the enormous amount of technical literature now in existence and the fact that it is growing exponentially,[7, 8] saturation being nowhere yet in sight, it is essential to have specialists to carry out the information work in all but the smallest units. To put it crudely in a nutshell, there must be library-trained specialists to do the document handling, and technically-trained specialists to do the data handling.

Nowadays, it is becoming increasingly necessary to employ language specialists as well. Some librarians and information officers, of course, are qualified to cover more than one of

these fields. In any case, there should be no argument as to who should rightfully do what. All should be regarded as members of a team (see references 9 and 10) and it is up to the seeker of technical information to address his inquiry to the person best suited to answer that particular request. If a search is required, for instance, he should remember that someone trained only in library science can do no more than an index search, whereas a technically-trained person can do a *literature* search. There is no subtlety in this distinction. An engineer will understand immediately what is meant.

With regard to the qualifications which should be held by the head of an information service, or of a library which has at the same time to be an information service, all authorities seem very well agreed (see any of the references quoted; the two examples given earlier are good illustrations). Apart from having the right type of personality, subject knowledge is considered to be of paramount importance. An appropriate degree is preferable, although some, for example, Mr. Foskett,[3] do not believe that " a degree in the subject is the only possible training for it " (p. 17). Later, however, to avoid misunderstandings, he says that he does not " belittle the possession of a degree; this, too, I think to be desirable, and the closer the subject to the work of the organization, the better " (p. 126), and ". . . without any doubt a science degree is a most valuable asset in information work, as in many other professions " (p. 125).

Another requirement, which again all authorities are agreed upon, is a working knowledge of at least two important foreign languages.

LIBRARY QUALIFICATIONS

Library qualifications are considered to be of lesser importance, although, of course, not to be despised by any means. Mr. W. Ashworth[11] has written, " a graduate with specialized knowledge of the firm's type of work should be preferred to a librarian with no technical qualifications." Two American experts[12] have written, " If it is not possible to employ a person trained in both library science and in the subject field, it is better to take one with the latter training; library work can be learned on the job, whereas the subject field cannot ordinarily be learned in this way."

In contradistinction, Mr. Foskett[3] says, " subject knowledge . . . *can* quite properly be acquired on the job " (p. 126, the italics are mine). It all depends, of course, on the complexities involved. Most people will agree that some subjects are more difficult to grasp than others, especially those which include advanced mathematics or chemistry. Nuclear science, chemistry or aerospace engineering, for instance, are vastly more complicated than, say, the manufacture of metal boxes.

In conclusion, the situation can perhaps be summarized best by quoting Dr. V. E. Parke[10] who said ten years ago:

" There are not yet any formal qualifications for an intelligence officer. [The position remains much the same today.] Good subject training is probably the best available and an interested officer can readily learn enough ' librarianship ' to meet his needs. Library Association qualifications are also valuable; chartered librarians can often pick up enough subject knowledge to deal with the simpler inquiries, but the *best* work needs more than this." (My italics.)

Yours faithfully,

P. M. HUGHES.

Esher, Surrey.
31 May, 1961.

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[2] Agard Evans, A. B., contribution to a paper read before the 20th Aslib Conference, entitled " Problems of Information Service in Industry," by E. N. Simons. Report on the 20th Conference, p. 60 (1945).

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[10] Parke, V. E., " An Intelligence Officer in Industry." Summary of this lecture is in *Aslib Proc.*, vol. 4, no. 1, p. 20 (Feb., 1952).

[11] Ashworth, W., *How to Set up Your Firm's Technical Information Service*, ref. EPA/INF/T/9228. Working document prepared by the European Productivity Agency of the Organization for European Economic Cooperation, Paris 16e (Undated, 1959 or 1960).

[12] Schultz, R. F., and Pfeiffer, G. H., " The Research Man's Helpers: Service Personnel and Facilities," being chapter XVIII of *Research in Industry: its Organisation and Management*, edited by C. C. Furnas. Van Nostrand, New York and London (1948).

Note: Some of the above references were discovered through the medium of *Records and Research in Engineering and Industrial Science*, by J. E. Holmstrom. Chapman and Hall Ltd., London (1956). This reference work includes a bibliography of over 500 items.

Events in Advance

Exhibitions and Conferences

Arranged in chronological order

St. Erik's Fair, 19th.—Wed., 30 Aug., to Sun, 10 Sept., in Stockholm. Agents: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London WC2. Tel. TEMple Bar 3422.

Handicrafts and Do-It-Yourself Exhibition, Ninth International.—Thurs., 31 Aug., to Sat., 16 Sept., in the Empire Hall, Olympia, London W14. Exhibition offices: Link House, Store Street, London WC1. Tel. MUSeum 9792.

Nuclear Development: Impact on Electricity Supply and on Instrument Techniques, Convention.—In September, in London. Organized by the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London WC2. Tel. COVent Garden 1871.

Leather Goods Trade Fair.—Sat., 2 Sept., to Thurs., 7 Sept., in Offenbach. Organized by Offenbacher Messe-Gesellschaft m.b.H., 110 Kaiserstrasse, Offenbach-on-Main, Germany.

European Fair, 36th.—Sat., 2 Sept., to Sun., 17 Sept., at Strasbourg. Organizers: Foire de Strasbourg, 9 Rue Brulée, Strasbourg.

Frankfurt International Autumn Fair.—Sun., 3 Sept., to Thurs., 7 Sept., in Frankfurt. Agents in the United Kingdom: Lep Transport Ltd., Sunlight Wharf, Upper Thames Street, London EC4. Tel. CENtral 5050.

Leipzig International Autumn Fair.—Sun., 3 Sept., to Sun., 10 Sept., in Leipzig. Applications in the United Kingdom should be sent to the Leipzig Fair Agency in Great Britain, 39 St. James's Place, London SW1. Tel. HYDe Park 3111.

German Welding and Cutting Exhibition.—Sun., 3 Sept., to Sun., 10 Sept., in Essen. Organized by the Gemeinnutzige Ausstellungs-G.m.b.H., 2 Norbertstrasse, Essen, Germany.

European Machine Tool Exhibition, Seventh.—Sun., 3 Sept., to Tues., 12 Sept., at Centenaire Palaces, Brussels. Organized by the Syndicat des Constructeurs Belges de Machines-Outils pour les Travaux de Metaux (SYCOMON), 13 Rue des Drapiers, Brussels 5, Belgium. In the United Kingdom, information is obtainable from the Machine Tool Trades Association, Brettenham House, Lancaster Place, London WC2. Tel. TEMple Bar 3606.

Levant Fair, 25th International.—Sun., 3 Sept., to Mon., 18 Sept., at Bari. Agent in the United Kingdom: Mr. Neven du Mont, 123 Pall Mall, London SW1. Tel. WHItehall 8211.

Salonika International Trade Fair.—Sun., 3 Sept., to Sun., 24 Sept., in Salonika. Apply to the Organizing Committee, Fair Office, Thessalonika.

Plasma Physics and Controlled Nuclear Fusion Research, Conference.—Mon., 4 Sept., to Fri., 8 Sept., at Salzburg, Austria. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria.

Discovery of the Nucleus, International Conference on (Jubilee Celebration).—Mon., 4 Sept., to Sat., 9 Sept., at Manchester. Organized by the Institute of Physics and the Physical Society, 1 Lowther Gardens, Prince Consort Road, London SW7. Tel. KENsington 0048.

Farnborough Flying Display and Exhibition.—Mon., 4 Sept., to Sun., 10 Sept., at Farnborough, Hampshire. Open to the public on Fri., Sat. and Sun., 8, 9 and 10 Sept., only. Apply to the Society of British Aircraft Constructors, 29 King Street, London SW1. Tel. TRAfalgar 3231.

Chemical Exposition, Eleventh National.—Tues., 5 Sept., to Fri., 8 Sept., in the International Amphitheatre, Chicago. Organized by the Chicago Division of the American Chemical Society, 86 East Randolph Street, Chicago 1, Illinois, USA.

Giving Packages an Overseas Appeal

DURING a four-day convention on "Consumer Packaging for Export," there will be discussions on the need for developing packages with an outstanding appeal to overseas buyers of all types of consumer goods, at which specialist speakers from Canada, the United States and other Western Hemisphere countries will take part alongside delegates from European countries.

The convention will be held in the Pillar Hall, Olympia, London W14, on 6, 7, 13 and 14 September during the run of the International Packaging Exhibition in the Grand and National Halls at Olympia. The convention is being organized by the Institute of Packaging, in cooperation with the Export Council for Europe and the Western Hemisphere Exports Council. A special display of British and foreign packs which have had a successful appeal to overseas consumers will be on show.

The programme of discussions for the convention will embrace foodstuffs and beverages; pharmaceuticals, fine chemicals and cosmetics; textiles and clothing; and household goods and domestic appliances. Applications for tickets and other communications relating to the convention should be addressed to the Institute of Packaging, Malcolm House, Empire Way, Wembley, Middlesex (telephone: Wembley 8623).

The Packaging Exhibition itself will cover the latest developments in all branches of the industry, including materials, packaging and printing machinery, and containers and packages. This exhibition is being organized by Provincial Exhibitions Limited in association with F. W. Bridges and Sons Limited and in collaboration with the Institute of Packaging. All communications relating to the exhibition should be addressed to Provincial Exhibitions Limited, City Hall Deansgate, Manchester 3. Tel. Deansgate 6363.

Meetings and Papers

The address and telephone number of the headquarters of each institution are given at the end of this list. Meetings in the headquarters town are held there unless otherwise stated.

Association of Supervising Electrical Engineers

CROYDON
" Public Supply Distribution;" Discussion. South London Branch. Greyhound Hotel, High Street, Croydon. Thurs., 22 June, 8 p.m.

Central London Productivity Association

LONDON
Annual General Meeting. Abercorn Rooms, Liverpool Street, Bishopsgate, EC2. Wed., 28 June, 12 noon. To be followed by luncheon; tickets, price £1 12*s* 6*d* each, obtainable from Mr. R. G. Cattell, 54 Alderney Street, London SW1.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London WC1. (LANgham 5927)
Central London Productivity Association. Apply to Mr. A. J. Boldero, Shell-Mex & B.P. Ltd., 1 Kingsway, London WC2. (TEMple Bar 8456)

Are New Models Teething Trouble Prone?

Reconciling innovation with reliability is one of the car maker's biggest headaches.

By John Rabson

THERE is a saying that the last few of an old model are always much better than the first batch of a new one. Like most generalisations, this statement is not universally true, although frequently it is very near the mark.

With the continuous process of development going on from year to year, the customer has every right to expect the benefits of this work when he buys a new car, and in very many instances he is satisfied with what he gets. Disregarding the merits of the technical advance that marks the introduction of a new model, one frequently hears of customer complaints, not about the basic design of the vehicle, but on points of detail which may reflect in some way on one or other of the phases of development, design and manufacture—and in fairness, one might perhaps add, on customer use.

The motor industry is not a new one; it is probably the most competitive branch of engineering in the country. In addition to the Motor Industry Research Association proving ground, there are a number of other research and development facilities up and down the country in the hands of the vehicle and component manufacturers, and at first sight one might think that it would be possible to get all the bugs out of a car in its prototype stage, before the design is released for production. Unfortunately this is seldom true, though it is the aim of all who are engaged in development. Company policies vary in different parts of the industry, but it is a significant fact that famous marques, with a reputation for sound engineering and long life, stress the importance of the function of development over and above original design. This may seem unusual, but the soundness of the policy can be appreciated when it is realized that it is the developed product, and not the ideas on a sheet of paper, that the customer pays for.

POLYGON OF FORCES

Producing a motor car will always be a matter of compromise, and the four sides of the manufacturing company tend to operate in the following way. The sales department wants large quantities of the new model yesterday, the design department will produce beautiful schemes which cost far too much, the development department will always be able to come forward with an improved version of something, at some time in the future, while the production department is happy only if the new components are exactly the same as those used on one or other of the previous models.

So it can be seen that time is never on the side of anyone wishing to make motor cars. Equally, no serious minded member of the industry would willingly wish to place in the hands of the public vehicles that had not been fully tested during the development period. Nevertheless, teething troubles do occur and this must be very disappointing to the proud new owner, particularly as his motor car is likely to be one of his most expensive single possessions. There is no simple solution to this problem—in fact it could be argued that in certain instances the advent of mass production does tend to aggravate the task.

Let us consider the production of a new small family car, and for purposes of argument assume that the design has considerable novelty, not only as regards appearance, but also in terms of mechanical layout or detail components used in its construction. Now the fact that it is to be made in quantity will presuppose very considerable capital expenditure on tooling for almost every part of the vehicle, and the fact that expensive tools are required also means that a considerable amount of time may be necessary for their production, before the first actual production car can ever be made. This is very important, because it is well known that there are always differences between the production car, made with the production tools, and the virtually hand-made prototype. On the other hand, it is on the prototype vehicles that all the initial testing and development work must be performed.

CROP OF MINOR FAULTS

Is this the reason for the crop of minor faults that sometimes occur on a new model, so that one still hears the comment, " yes, that looks like an interesting car—perhaps in six or nine months' time when they have got all the bugs out of it I will buy one "? The fact is, of course, that as well as developing the actual prototype vehicle, in some cases there must be a development period for the tools and plant on which it is to be produced.

Therefore, the newer the vehicle (and in this context newness means degree of engineering novelty), the greater will be the amount of new plant and equipment required to make it, and consequently the potential number of snags or faults in early production batches will be increased.

The vehicle manufacturer is fully aware of all these problems, and takes very great pains to eliminate them where it is humanly possible to do so. There are many ways of doing this, and perhaps one of the most popular is to reduce the " new " content of any new vehicle that is introduced at any one time, and thereby reduce the number of completely new features that are inflicted on the customer.

For example, quite often a new unit body structure may house an existing engine and transmission unit during the first year or two of production, while later the engine may be replaced by one which is more powerful or more refined. In this way, the risk of early mechanical teething troubles coinciding with minor body faults is eliminated, and there is, of course, the added advantage that body components made with the production tools can be used during the development of the second stage.

STAGGERED INNOVATION

On the other hand, if it is necessary to make certain that a completely new engine and set of mechanical components is available at a time when a completely new car is to be launched, it is not unknown for the power unit to find its way first into a limited production vehicle with a relatively less complicated body, such as an open two-seater sports car, and after a satisfactory period to be transferred to, say, a luxury saloon.

From time to time, particularly if it is necessary to force a breakthrough and produce a design that has considerable novelty, these methods are not always possible. When this happens there is a likelihood of a greater number of teething troubles during the early production stages, and a corresponding need for increased development work, not only by the vehicle manufacturer, but also by the very large number of component suppliers who feed the complete vehicle producing companies.

In the component industry, development policies vary. Some companies appreciate its importance more than others, particularly if their line of business tends to bring them into closer contact with the purchasing public, as opposed to the bulk customer. However, with the best will in the world on all sides, faults do sometimes occur in service that have not been experienced during prototype or production development stages. One of the most difficult things to simulate is the treatment vehicles receive at the hands of some members of the public, and probably the only way of finding out such faults is to place the vehicle in the hands of the aforementioned members of the public.

The Mini-Minor (above) and the Anglia (below) both represented complete departures in design, but both have survived launching with notable success.

Even the most clumsy person that you can find to put on vehicle road test will acquire at least a limited degree of skill (by reason of his occupation), which may instinctively prevent him from doing just those things which might produce complaints from certain sections of the public. Alternatively, it might be difficult, because of this acquired skill, to stop him from producing faults which would not occur under normal use, and which would, were they to result in modification, cause unnecessary complication or refinement, with a corresponding increase in cost. The problem must always be resolved in terms of economics, and development is a very costly operation.

The amount of development, or for that matter any other work put into a product, must reflect on the ultimate cost. If this cost is to be kept low, there is always a chance that a few faults will occur in the hands of the public, and the more new features there are in any one new car, the greater will be the danger of this happening. Provided that they do not result in any danger to life or limb this is not too serious—if there is a satisfactory mechanism to remedy them with the minimum amount of inconvenience to the customer.

" SHOW ME ONE THAT ISN'T "

Probably this obligation means that an even greater degree of service must be provided by the distributors, dealers and garages generally, to ensure prompt rectification of minor troubles occurring in the field. The attitude sometimes taken, such as " show me one that isn't," as a reply to a complaint that the transmission in your car is excessively noisy, or the lock is difficult to open, is certainly not a helpful one—even if it may sometimes be true. Customers have every right to complain if something is wrong, but it is surprising how quickly criticism of a model may be converted to praise for it, if prompt measures are taken by the manufacturers to deal with reasonable complaints as quickly as possible.

Ineffective service can do much to destroy customer confidence in a car, particularly if the mechanic who corrects one fault somehow manages to produce others in the process.

Today, most cars are bought as a necessary means of transport. Much has been done to reduce the need for frequent servicing, and some components have a guaranteed or insured life. Has the time come to extend this still further? Surely a moderately priced car which would be guaranteed to give, say, 100,000 miles of motoring before any major item required overhaul, would have very considerable sales appeal. It would also stimulate development.

Human Element

Whitworth Foundation Awards for 1962

Three Whitworth Fellowships are being offered by the Ministry of Education. The outstanding award in engineering, Whitworth Fellowships are held by practising engineers who wish to take a post-graduate course in Britain, or overseas, in an approved establishment or industrial organization.

Each award is worth £1,000 a year, plus additions for dependants, travelling and subsistence. Whitworth Fellows, the beneficiaries of the Whitworth Foundation Scheme, have a particularly high record of success in reaching senior positions in industry, in education and in the public services.

Former Whitworth men include Mr. J. D. Pearson, chief executive and deputy chairman of Rolls-Royce, Dr. J. A. Pope, research director of the Mirrlees National Research Division, Professor J. Diamond, of Manchester University, Professor S. J. Davies, Dean of the Royal Military College of Science, Dr. H. L. Haslegrave, Principal of Loughborough College of Advanced Technology, and Dr. J. W. Drinkwater, director of Engine Research and Development at the Ministry of Aviation, among many others.

Applicants, who must be over 25, should hold a degree in engineering, a Diploma in Technology (Engineering), a Higher National Diploma or certificate in engineering with at least two distinctions, or a qualification accepted by the Ministry of Education as of equal standard. Three years experience as practising engineers is also necessary and the Fellowships are open to women who satisfy the conditions.

Three Whitworth Exhibitions of £100 will be granted to unsuccessful candidates whose work is judged worthy of recognition.

Applications, available from the Ministry of Education (FE3C), London W1, should be returned to the Ministry by 31 July this year.

Keep Your Head in a Safety Helmet

The first two members of the Royal Society for the Prevention of Accidents' new YZ club—for industrial workers who by wearing a safety helmet or hard hat have saved themselves from serious injury from falling materials—are clear examples of the principle "if you want to stay alive wear a hat."

The YZ club's founder members were both struck on the head under circumstances in which without safety headgear they might have lost their lives.

Mr. D. C. Hicks, a process operator at British Titan Products, Pyewipe, Grimsby, Lincolnshire, was struck on the head by a damaged section of wired glass roof light which fell about 30 ft. The section, measuring 2 ft 6 in by 2 ft, was dislodged by vibration.

The Industrial Safety division of RoSPA make the cautious comment that by wearing a safety helmet Mr. Hicks saved himself from serious injury. His head was bruised and he suffered laceration of the left arm but was able to continue at work.

Mr. R. W. Harrison, a tackleman at Dorman, Long (Steel), of Redcar, Yorkshire, was helping in the erection of piping beneath a steel plant charging stage. A piece of steel scrap weighing about 28 lb fell from the furnace pan bench 15 ft above. The steel scrap struck his helmet, slightly damaging it but not in any way hurting Mr. Harrison.

YZ club lapel badges, made up of the letters YZ in gilt and enamel, and membership cards signed by Sir Howard Roberts, president of RoSPA, have been received by both men.

Behind the formation, last October, of the YZ club, lies the valuable purpose of encouraging employees to take a greater personal interest in preventing industrial accidents.

Full figures are not available in detail for a later year than 1959 but in that year 14,547 workers were injured as a result of being struck by falling objects. 72 of those struck died. Of the total number injured by falling materials or parts, 9,029 accidents caused head injuries, and in many cases the wounds would have been avoided, or at least much reduced, by the wearing of proper head protection.

Rewards and Pitfalls in Industrial Training

If training can improve the effectiveness at their job of 20 men by 5 per cent each it will be the same as adding another man to the staff—free of costs. This is the highly appropriate conclusion drawn by an instructor of the Maintenance Education Department of the Dow Chemical Company, in his paper "Our Experiences in Instrument Training Programs."

Answering the question, why did they need to train instrument men, the company had to discover whether they could go out and hire skilled men, whether such men would know how to maintain Dow equipment and whether they would be familiar with developments in the electronic equipment and allied fields. The answer was an all-round no, leaving no alternative but a training programme.

Who Shall Teach?

The very great responsibility of the company's instrument men led to the adoption of particularly careful selection methods. A range of achievement, aptitude and interest tests are used. Physical needs are taken into account and an interview with the superintendent of the department is arranged.

A recurring question is that of who should do the instructing. There are certain advantages in having the foreman or superintendent do the teaching, but two major disadvantages at once appear. The men in these two positions are unlikely to be trained, or to have become skilled in, the techniques of effective instruction. They are normally too busy with their own responsibilities to give sufficient time to the preparation for classes. Dow have reached good results with full time instructors with a background in education and some training and experience in the field.

Each man on the course is in class from four to six hours a week in two or three two hour periods. Classes are held during the working day in rooms provided on the company's premises.

Since 85 per cent of the two year training period is spent in the shop or the field it is important that the trainee should be given a broad work experience. By careful planning, each trainee is able to work with as many foremen and journeymen as possible.

By in-training test programmes and the use of foremen's rating sheets, a check is kept on individual progress. Should a man fail any test he meets his supervisor, steward and instructor to discuss his progress. If he goes on failing he leaves the trade.

All company training is under contractural agreements arrived at between Dow and the union. Union assistance is regarded as necessary when originating or altering a programme, for three reasons. The union representatives are often closer to the job and understand what is needed. Better acceptance by the men can then be anticipated. And without union consent, it is felt that no formal training programme will be possible.

No Real Conflict

There is a basic conflict between the view that the longer the man has held a job the better his rate should be and the better his security, and the alternative need in quickly changing industries to constantly train and retrain men, so that a quite senior worker may have to start over again, so far as seniority is concerned, in a particular position.

As happens, a return to basic principles helps considerably. The first purpose of trade unions was, and is, to improve the pay, security and various benefits of the members. Training an employee at the company's expense and in the firm's time is a particularly happy way to go about seeing that the member is upgraded. Security is, for the trained worker, whether in the United States or Great Britain, a more real possibility than for the unskilled.

Endeavouring to evaluate their educational programme, the Dow company found that shop supervisors thought that the programme had done a good deal for them, that they would have difficulty in operating without it. This opinion was shared by the trade union and by the men in the shops. Fewer men are now needed for maintenance work, less supervision is required for the trained men, and the labour cost per work order has been reduced.

The Dow instructor suggests five points for the establishment of a training programme. One, it should be decided whether or not training is really necessary. Two, the help of the union should be sought. Three, methods of grading and maintaining achievement standards should be decided, this covers relating pay to progress on the course, failure penalties and so on. Four, an adequate teaching staff should be obtained. Five, means of assessing the programme should be chosen.

Questions at the Top by Laing Pupils

Directors of the civil engineering John Laing company took part in a question and discussion session with 100 articled pupils during the company's ninth annual pupils' conference held earlier this month as the climax of Laing's participation in Commonwealth Technical Training Week.

The articled pupils came to the conference from all around Great Britain and were taken on tours of the Laing plant and transport depot and the research and development laboratories.

First and final year pupils attend the annual conference. This year's winner of the best all-round pupil award was Robert H. Trew, 21-year-old contract management trainee, now working in Bristol.

Mr. W. Kirby Laing, the company's chairman, stressed in his address to the conference that it is the group's policy to train people within the organization for positions of responsibility wherever this is possible.

Imaginative Compensation Scheme at Steel Firm

The compensation plan to be applied by the Steel, Peech and Tozer company of United Steel Companies Limited for loss of status and earnings by its workpeople affected by the Operation Spear modernisation programme is described by USC as compensation for loss of earnings under exceptional circumstances.

True as that undoubtedly is, the imaginative and sensible provision made by the company is bound to act as an educative influence on future industrial schemes to compensate workpeople who have contributed effort and skill to organizations whose modernisation developments lead to their doing jobs with different skills and lower earnings.

Consultation with the unions and just compensation payments at the time of change over can make for a smoother transition and enhanced labour relations instead of an interval of strife and permanent fear and bitterness later.

Operation Spear—Steel, Peech Electric Arc Reconstruction—will give Steel, Peech and Tozer the largest electric steelmaking plant in the world. It will have an annual capacity of 1,350,000 ingot tons of steel, against a current capacity of 1,000,000 tons. Twenty-one open hearth furnaces are being replaced by six 110 ton capacity electric arc furnaces. The labour force will be reduced by more than 1,000 men.

Redundancy

Some will be retired but inevitably a number will be redundant. It is hoped that none of the permanent members of the labour force will be made redundant and that redundancy will be confined to the temporary employees. The company expects to be able to offer unbroken employment to its established regular employees although some will have to be offered jobs in departments other than the new melting shop. These positions will, in the main, be less highly paid and in the new melting shop itself there will not be as many highly paid jobs as at present.

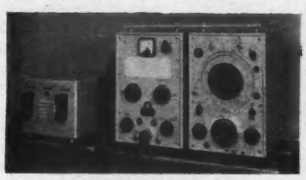
The earnings of hundreds of workpeople will fall. For the greater number of those affected there will be a loss of from £3 to £6 a week.

The three factors being taken into account in arriving at the compensation to be paid are: loss of earnings, years of service, and age. The top payment to any individual will be £300.

For United Kingdom or any other steel making firms to keep up with the world wide competition, new plant and savings in labour costs are essential. The steps being taken by Steel, Peech and Tozer to mitigate the inevitable hardship are worth considering by others who find themselves in a similar position in the future.

RADIO-TELEPHONE

For Small Craft



THE "Kestrel" is a new radiotelephone transmitter-receiver designed for small vessels.

It is suitable for drifters, trawlers, coasters, or harbour service craft which require efficient, medium powered communication with shore stations and, by link calls, with the offices of their owners and with the harbour authorities.

Frequently the limitations of space, power supplies and budget which affect these vessels preclude the provision of high-powered and bulky radio equipment. The "Kestrel" is a compact unit with Consol and direction-finding facilities, simple to operate and occupying the minimum of space. The transmitter and receiver units are of similar dimensions and can be mounted either side-by-side or one on top of the other, as convenient.

The receiver covers a frequency band of 190-4,500 kc/s, and includes visual Consol reception and direction finding. It may be used with a radiogoniometer unit and fixed or rotating loop aerial, and can also function independently of the transmitter.

The transmitter, with 11 spot frequencies in the band 1·6 to 3·8 mc/s, can be operated on either the duplex or simplex system. The "Calling and Distress" frequency, 2,182 kc/s, is clearly marked on transmitter and receiver controls. Metering facilities enable valve feeds, LT and HT supplies and Consol reception to be checked at a glance. The power unit operates from either 24 or 12 volt batteries.

A power output of 36 to 50 watts is delivered into a wire aerial of 60 to 100 ft, or a whip aerial of about 20 ft in length, although in the latter case the frequency range is limited to the band 2 to 3·8 mc/s, with some reduction in radiation efficiency. *The Marconi International Marine Communication Company Limited, Chelmsford, Essex.*

PHOTOELECTRIC EQUIPMENT

Transistorized

AVAILABLE in alternative versions for counting or switching applications, the new Series TPU1 range of transistorized photoelectric equipment has recently been announced.

When used for counting applications, the unit is supplied complete with a Series F43 electromagnetic counter, which is energized directly from a transistor switch circuit. In this configuration the unit is designed to operate up to a speed of 1,500 counts per minute. Six figure indication gives a total of 999,999 counts, with manual reset.

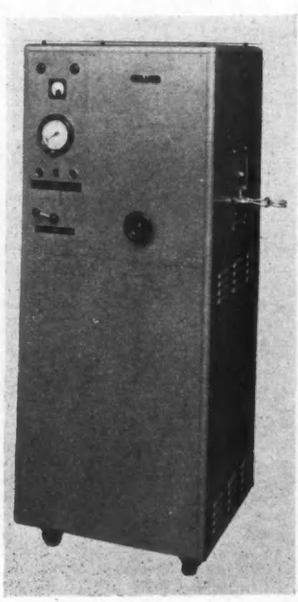
In those applications where photoelectric switching is required, the unit is supplied with an integrally mounted relay having one pair of normally open and one pair of normally closed contacts rated at 3 amperes at 230 volts ac. Here the unit is suitable for operation at switching rates up to 300 per minute.

With the standard 8 watt remote mounting light source unit, both versions are suitable for operation over a range of 25 ft. The light source unit obtains its supply directly from the photoelectric unit and no additional supplies are required.

The series TPU1 range of equipments is suitable for operation from 100/115 or 200/250 volts, 50 cycles supplies *Lancashire Dynamo Electronic Products Limited, Rugeley, Staffordshire.*

INDUCTION GENERATOR

Simplicity of Operation



AVAILABLE in either air or water-cooled versions, the latest Pye induction generator illustrated here has been designed for continuous operation.

The production of both medium and high work coil kVA permits the heating of a wide range of ferrous and non-ferrous loads. The output power can be varied by means of a stepped control, and the inclusion of an automatic resetting process timer makes accurate repetition work possible.

The design incorporates safety devices, which include water pressure switches, and overload relays.

This new electronic heater also includes provision for remote output indication and remote "on/off" control.

As shown here, the heating coil is at the upper right hand side of the equipment. Simplicity of operation of this compactly designed instrument allows unskilled labour to be employed, with consequent reduction of production costs. *Pye Limited, Process Heating Division, 28 James Street, Cambridge.*

AUTOMATIC TUBE BENDER

Programme Control

UP TO twelve bending variations can be conducted without resetting any levers on the Staffa-Herber SBA 28 machine illustrated.

The machine is designed for high speed repetition work and is capable of making from 500 to 600 bends per hour. The maximum capacity for steel tubes is 1½ in outside diameter by 16 swg thick, and for non-ferrous tubes of equivalent larger size. It is a mandrel type machine with a pipe length stop assembly with ten adjustable stops. These are lifted centrally as the tube is loaded over the mandrel.

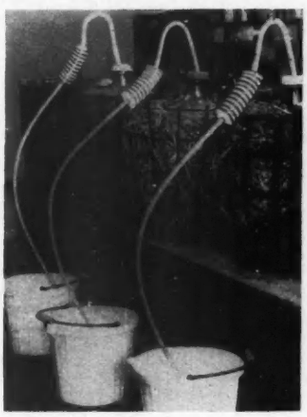
The drive unit is composed of a worm gear running in an oil bath and the system is operated by a steel disc clutch.

A patented device permits right and left hand bends to be made without resetting the machine and tooling. This is possible even when there is no straight between the bends. In certain cases also the device allows for bends of different radii to be produced without the necessity of having to change centre formers.

A pre-selector on the control panel allows up to 12 bending variations to be made without resetting any levers, and is automatically controlled. After each completed bending operation the bending head returns automatically and the work piece is rejected from the centre former groove. *Chamberlain Industries Limited, Staffa Works, Argall Avenue, Leyton, London E10.*

SYPHON

For Safe Transfer



A SYPHON of simple construction, introduced by Dohm Limited, is intended for the safe and economical transfer of dangerous liquids from one vessel to another.

The device, with potential applications in every sphere where dangerous liquids are dealt with in any quantity, is manufactured from corrosion resistant polyethylene. Known as the Dohm-Vorax, the syphon consists simply of a tube, with a tap at one end and a concertina-like bellows towards the other.

To operate the device, the tap is turned to the closed position and the bellows are compressed. The open end of the tube is then inserted in the vessel from which the liquid is to be taken. The bellows pump is released and liquid is drawn into the tube. By opening the tap, the liquid is allowed to flow freely through by syphon-action, with the flow always readily under control.

It is claimed that in this way all liquids can be transferred with a minimum of danger to workers and without the mess and waste associated with tipping and pouring from one heavy vessel to another.

Two models of the syphon are available: model AA, bellows capacity ¼ pint, and model A AG, bellows capacity 3 pints. *Dohm Limited, 167 Victoria Street, London SW1.*

WATER METER

Highly Resistant Components

KNOWN as the Type 44, this compact water meter has recorded more than 3,000,000 gallons under difficult water conditions without maintenance or loss of accuracy.

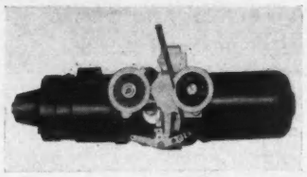
All components are made of materials combining high mechanical strength with resistance to bacteriological and hygroscopic deterioration. The measuring chamber of precision moulded polyamide is protected by a fine mesh filter. Gears and pinions are of polyamide with stainless steel spindles and self-lubricating bearings.

The two-part gunmetal casing screws together, and components may be replaced without using tools.

Available in the ¾ in size with either wet or dry dial, the latter version with centre pointer or direct reading index, the new meter can handle accurately flows of 400 gallons per hour at 10 ft head loss continuously. At flow rates as low as 5 gallons per hour the accuracy is guaranteed to within ± 2 per cent. The Type 44 is hydrostatically tested to 300 lb per sq. in and can sustain continuous working pressures of up to 150 lb per sq. in. *Parkinson Cowan Measurement, Dobcross, Oldham, Lancashire.*

PNEUMATIC CONTROL UNIT

To Reduce Overshoot



A TWO-TERM pneumatic process control unit for use on batch processes is announced by Honeywell Controls Limited.

Designed to counteract "overshoot" on start-up, the unit is known as the Batch Air-O-Line and is suitable for use with electronic strip chart recorders and pressure gauges.

With some proportional-plus-reset pneumatic control devices, when the recording pen is outside the proportional band, accumulation of air in the system during the shut-down procedure will cause overshoot on start-up. This gives rise to delays in processing and endangers quality. The Batch Air-O Line will reduce or prevent overshoot by automatically discharging accumulated air when the pen moves out of the proportional band.

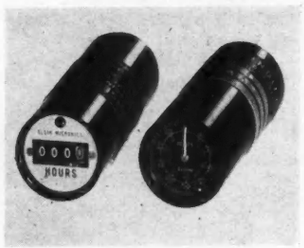
In operation, when the process is shut down, the controller output increases. When it reaches 15 lb per sq. in a bleed valve opens to exhaust the accumulated air and the proportional band is simultaneously shifted downscale by blocking off the reset chamber. The controller output thus maintains a saturated condition during the shut-down period.

On restart of the process, the reset chamber exhaust is shut and air returns to the reset chamber, reducing the controller output. The proportional band gradually shifts upwards and set point is reached without the usual cycling.

The manufacturers emphasize that the new technique does not slow the response of the process. In fact, the approach to the set point is simply made in a more gradual way at the moment of starting up. The normal pattern of process control continues without any alteration in subsequent operation. *Honeywell Controls Limited, Greenford, Middlesex.*

ELAPSED TIME INDICATORS

"Electro-Clocks"



WITH the production of the instruments illustrated, what are claimed to be the smallest electro-mechanical elapsed time indicators in the Western World have become available. These miniature "electro-clocks" record the precise operating time of electronic equipment and instrument systems.

Weighing about 1¼ oz each, these instruments are suitable for airborne systems, missile ground support applications and many other fields.

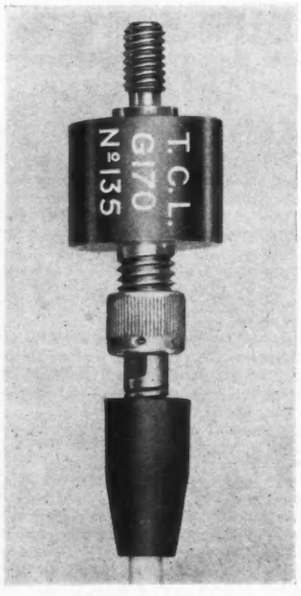
The need for elapsed time indicators of this standard has arisen as reliability requirements for complex equipment have been more exactly defined in terms of operating time. Elapsed operating times are used as the basis for maintenance and replacement schedules, with consequent economies.

The indicators give either a dial or digital reading, and will record up to 1,000 hours. They are of cylindrical shape, with a diameter of 0·680 in and length 1·42 in (dial type) or 1·76 in (digital type). Operation is by a synchronous electric motor and gear train available for single-phase 400 cycles 115 volt or 26 volt; there is also a 28 volt dc model. Power consumption is 1 watt.

Environmental standards provide for vibration up to 20*g*, 10-2,000 c/s, with temperature limits of −65° F through to 250° F. All shafts rotating at over 5 rpm have sapphire bearings. The units are filled with an inert atmosphere and hermetically sealed. All coils are encapsulated in epoxy resin; no shorting to earth occurs under operation within the specification conditions. The dial type is readable to within 0·1 per cent. *Aeromaritime Limited, 45 Ladbroke Square, London W11.*

ACCELEROMETER

Very Light Weight



A LIGHT weight accelerometer, the type G170 has now been introduced for vibration tests.

Particular applications are in the aircraft and automotive industries and in the development of shockproof packaging techniques. The light weight of 5 gm enables it to be used for testing component parts as well as complete assemblies. It is only ½ in long and ½ in diameter.

The operating range is from 5 c/s to 3·5 kc/s and shocks and vibrations in the range from 0·1 to 400*g* can be measured. The operating temperature range is from − 40° C to + 80° C and the units are fully sealed to withstand high humidity.

The accelerometer uses a bender type transducer to give maximum sensitivity in a coaxial direction with minimum sensitivity in other directions. A high self-capacitance enables measurement to be made at low frequencies using a cathode follower unit. *Technical Ceramics Limited, Wood Burcote Way, Towcester, Northamptonshire.*

CENTRIFUGAL PUMP

Integral Power Unit

THE Alcon Thames 1½ in CD2 centrifugal pump is the first application of the new Villiers D-270 lightweight high speed diesel engine.

This integral unit is compact, portable and economical to run. The operational characteristics of the unit make it suitable for the builder, contractor and civil engineer.

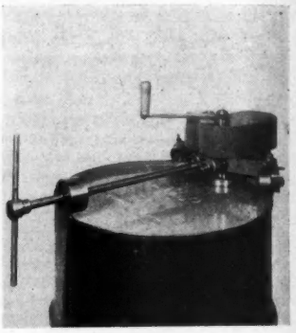
As the engine is directly coupled to the pump, forming an integral unit, it is not possible to fit alternative prime movers. In the event of other prime movers being required, then the 1½ in BH2 driving head unit, a part of the Alcon Thames range, would be used.

The maximum total head is 125 ft with a maximum output of 6,500 gph. The suction lift is 18 ft, and the pump is not self priming. Close grained cast iron is used in the pump casing, which can be horizontal or vertical in discharge as required. The impeller is of gunmetal, hand finished and balanced. Passages are provided through the hub to relieve stuffing box pressure and give hydraulic balance. Impeller rings are of renewable bronze, and so is the sleeve which extends through the stuffing box protecting shaft. A gunmetal gland and rubber water thrower are provided.

The diesel engine is air cooled, four-stroke, and develops 4 bhp at 3,000 rpm. This vertical single cylinder engine weighs 160 lb and has an unusually high power-to-weight ratio. Fuel is carried in a 1 gallon tank forming the engine base. Rotation of the crankshaft is clockwise, viewed from the flywheel end. Starting is by means of a detachable starting handle. *Arthur Lyon and Company (Engineers) Limited, Park Works, Stamford, Lincolnshire.*

DRUM OPENER

Hand Operated



A NEW device with useful applications in many industrial fields, the drum opener illustrated, the Model CD, was introduced recently.

The machine is designed to cut the top off steel drums of almost any size. It is operated entirely by hand, and is fitted with suitable gauging rollers which hold it in position on the drum.

The operating handle acts through reduction gearing, and the effort required to use the opener is small. To secure maximum working life, hardened tool steel is used for the cutters themselves. All components are made to machine tool standards. These design features ensure that the top edge of the drum body is cut square and clean and is thus rendered suitable for subsequent reconditioning if required, or for other use.

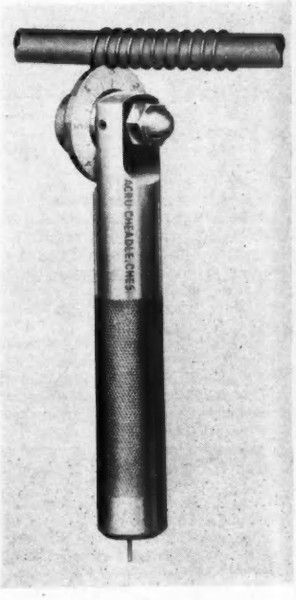
In a variety of applications the oil, chemical and paint industries take prominent positions. The Model CD will appeal to any other user who requires the rapid removal of a quantity of drum heads for full diameter access.

The application of the machine in drum reconditioning plants is of particular interest. Here it is sometimes necessary to remove old end stampings and re-flange for double seaming new stampings, or to curl the top edge of the body externally for the fully-open top type of drum.

The clean edge that is left by the drum opener facilitates both flanging and curling. *Moon Brothers Limited, Beaufort Road, Birkenhead, Cheshire.*

SPRING WINDER

For Small Quantities



NOW on the market is an improved version of a hand spring winder.

The tool is intended for making up coil springs where only a small number are required and the expense of machining is not justified. The coil of wire is fed through the handle of the tool, and passed between a steel disc and a plastic disc which are clamped together to grip the wire. The clamping pressure can be varied according to the diameter and hardness of the wire.

The wire is then wound on to a rotating mandrel, the spacing between the turns being regulated by setting a tapered disc to the desired value and keeping one edge against the wound turns of the spring. It is claimed that the use of a new plastic for the clamping disc makes it easier to control the pressure. The tool is capable of winding springs with wire up to $\frac{3}{16}$ in diameter and with pitch up to $\frac{1}{16}$ in also. *Acru Electric Tool Manufacturing Company Limited, Acru Works, Demmings Road, Councillor Lane, Cheadle, Cheshire.*

SANDERS

Orbital and Disc Types

MANUFACTURED by Rupes of Milan, two new orbital and disc sanders will be of interest to panel beaters, garages, metal workers, welders and fabricators, and stove enamellers.

An important feature of the "Super Stork" 7000 orbital sander illustrated is its ability to function in wet conditions. Of ¼ hp and 7,000 rpm operating speed, it is light in weight at 7½ lb. Other advantages of the machine include double insulation, proof against vibration and the fact that it can be used to full effect on curves and shapes and will not slow down under pressure. Its orbital motion ensures a smooth finish.

Applications of this model include rubbing down and flattening work in the motor industry, final finishing of metal work and welds, flattening in stove enamelling and sanding of wood floors.

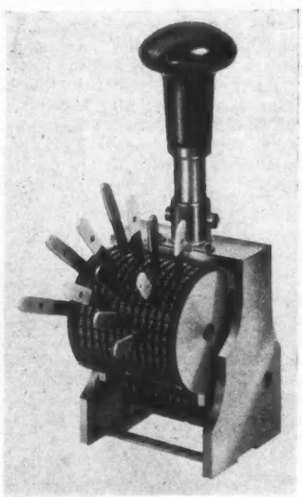
The vertical model "S.M.10" disc sander can be easily adapted for boring; the equipment for which is supplied with the sander.

With this machine also, greater efficiency at 1 hp under normal loading conditions is claimed. The machine is designed so that its weight is distributed over the working surface, thus reducing operator fatigue.

The "S.M.10" operates at 4,200 rpm, and will not vibrate or slow down in use. Twisting out of the operator's hand is not possible. The operator is protected by a steel guard and insulated handles. Applications of the machine include ripping out, grinding, scurfing panels after beating, scurfing lead and welds, sheet metalwork and paintwork. Sole concessionaries for Great Britain are: *Marron Machines Limited, 2 Newark Parade, Watford Way, London NW4.*

CODING MACHINE

Positive Setting



FAST AND ACCURATE in operation, the "Dedruma" coding machine is specially suitable for marking contents labels, weights, quantities, batch numbers, operators' references, electrical data, rates for piece work, job cards and envelopes, internal forms and files.

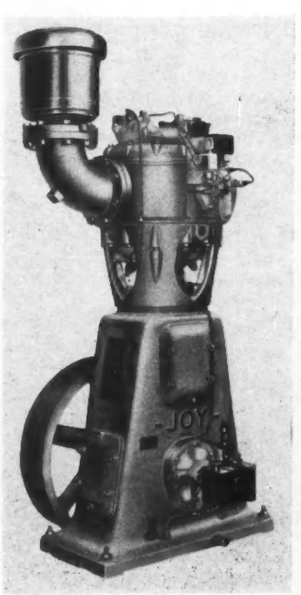
The machine is fitted with colour-capped levers which have a smooth action and click positively into position against the required symbol or number on the drum, ensuring ease and accuracy of setting. Once the levers are set, they cannot be moved accidentally and the complete visibility of the setting guards against errors.

"Dedruma" hand-operated models are available with from 4 to 12 wheels, and for special applications, models are available with up to 32 wheels. In the case of the larger models, a foot operated stand is recommended by the manufacturers.

The wheels, which are made from hardened solid brass, can be engraved in clear-face letters, symbols or combinations of code names, in characters from 2 mm to 8 mm high. *Westwood Paper Limited, 185, Goswell Road, London EC1.*

AIR COMPRESSOR

Heavy Duty



FEATURING compact vertical design and rated for 24-hour heavy duty applications, the Joy WG-9 industrial air compressor was announced recently.

The WG-9 is a single cylinder, single stage, water cooled unit, designed for service as a main air supply for all small factories and plants or as an auxiliary supply for larger plants. Available in six cylinder-stroke sizes giving free air delivered outputs of 75 to 334 cfm at working pressures of 15 to 150 lb per sq. in, the largest of these compressors requires a floor space of only 3 ft 0 in by 3 ft 5in.

In a lower capacity range not already covered by the manufacturer, the series has a complementary range of WGO-9 compressors which give oil free air.

Erection is readily carried out from an integrated pre-aligned "package" unit. Standard drive is by Poly Vee belt; direct couplings or gear boxes can be fitted for use with diesel engines. *Joy Sullivan Limited, Air Power Division, Cappielow, Greenock.*

POWER PACK COMPRESSOR

Mobile

RECENTLY introduced is a 130 cfm self-propelled power pack compressor, manufactured by Air Pumps Limited. This equipment is now available for the UK market as well as for export.

Designated as the "Travelair," this mobile air power unit is made up basically of Ford Thames 15 cwt components, with a Ford 592E four-cylinder diesel engine driving the manufacturers' 130 cfm airflow-cooled two-stage compressor.

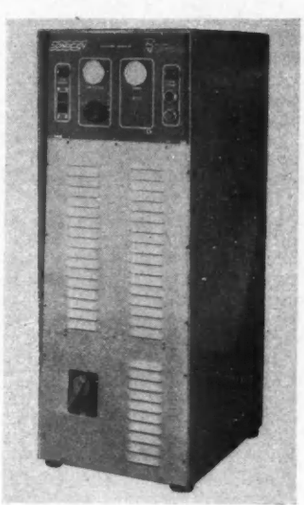
One of the most outstanding features of the "Travelair" is in the fact that the same diesel engine which drives the truck also runs the compressor. This arrangement has been achieved by the provision of direct drive, and this enables the Ford engine to supply power direct to the compressor, and also to the transmission which gives the power source for the vehicle's mobility.

As there are no gears in the system, no power loss is sustained; while the fact that the power for both the truck and the compressor arises from the same source eliminates the need for cold starts of the prime mover several times a day.

Notable for its compactness as well as for its robust and attractive design, the "Travelair" can go anywhere a normal vehicle can go. The unit runs at usual road speeds. An 18-gallon fuel tank is fitted and two tool boxes are incorporated, these being large enough to hold breakers, rock drills, steels and hoses. The manufacturers claim for the "Travelair" that it represents mobile air power in a complete form. *Air Pumps Limited, Bushey Road, Raynes Park, London SW20.*

ULTRASONIC GENERATOR

Automatic Loading



BECAUSE it automatically adjusts itself to variations in cleaning load, this large single-unit ultrasonic generator is particularly suitable for high-speed ultrasonic cleaning and large volume or heavy-duty batch operations.

Called the Model LG-3500A Sonogen, the new unit offers an average power output of 3,500W, with a peak on pulses of 7,000W. High-speed cleaning of steel strip, multiple-strand wire cleaning machines and long conveyorized systems are examples of its use.

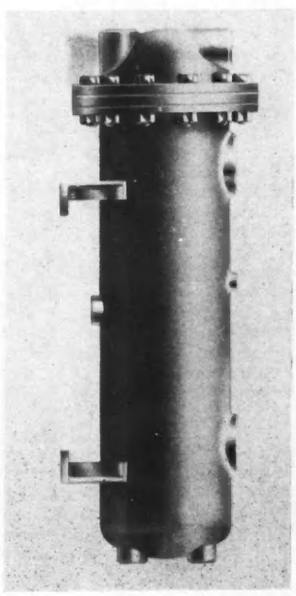
The automatic load system is notable in that it compensates for both frequency and impedence simultaneously, to keep the acoustic energy in the cleaning system at peak performance level.

The generator is designed to drive Sonogen-Z transducers, which can accept high input power and permit operating temperatures up to 200° F.

Heavy duty components assure maximum useful operating time and long life. Housed in an aluminium cabinet and designed for easy maintenance access, the unit measures 18 in by 24 in by 48 in high. *Branson Europa, N.V., Industrieweg 14, Loosdrecht, Netherlands.*

CALORIFIER

Non-Storage Type



A NEW range of non-storage calorifiers has recently been introduced by Holden and Brooke Limited, designed to cover heating engineers' requirements.

The calorifiers are available in two series. There are 19 sizes of the "Nordon" type, with capacities up to 8,000,000 Btu. The "Wython" calorifiers, which are built to BSS.853, are manufactured in sixteen sizes to a maximum capacity of 6,000,000 Btu. The sizing of a unit for a given duty presents no difficulty, since a nomogram is provided on the literature for the standard duties required of this type of calorifier.

Both types can be assembled as horizontal or vertical units without affecting either price or delivery.

The steam pressure limits on the primary side are 5–100 lb per sq. in, and the shell side maximum working pressure is 50 lb per sq. in. The construction is principally mild steel welded, with cast-iron steam boxes and solid-drawn copper "U" tubes. *Holden and Brooke Limited, Sirius Works, Manchester 12.*

Four Berths Built at Mombasa Harbour

New berthing facilities have been built for the East African Railways and Harbours authority at Mombasa. Loss of filling by tidal flow from reclaimed areas has been prevented by a graded stone filter behind the new quay walls.

EARLY in 1955 the possibility that additional berths might be required at Mombasa Harbour was examined and it was concluded that, on the basis that the tonnage of total cargo to be handled continued to increase by 5 per cent annually, a further two berths would be necessary in 1961.

Plans were prepared and tenders invited for the construction of three new berths each 600 ft in length with 33 ft depth of water at low water. At the same time tenderers were required to state their price for constructing a fourth berth if instructions to do so were given not less than 15 months before the completion of the first three.

The tender of Christiani & Nielsen, J. L. Kier and Company was accepted on 20 December, 1956, for the construction of four berths and work at the site started in March, 1957, on the contractor's temporary buildings and work-yards. A plan of the new berths and a typical cross-section are reproduced below and the photograph shows a general view of the new berths and of the reclaimed area with the reinforced concrete transit shed on Berth No. 12 in the middle foreground.

Each of the four berths consisted of a reinforced concrete deck 67½ ft wide supported on precast reinforced concrete piles. The two seaward rows, which carry the quayside cranes, are 21 in square and 55 ft to 85 ft in length, the two centre rows of piles are 18 in square and vary from 45 ft to 75 ft in length and the landward row consists of pairs of 16 in square piles driven at a rake of 1 in 5.

At the back of the concrete deck a retaining bank of rubble stone was constructed to take the horizontal thrust of filling placed behind the quay to reclaim an area for railway tracks, sidings and an open storage. The rubble bank was formed by dumping stone from barges and was brought up in layers starting at the east end and working westwards. From 6 ft below low water the rubble was placed from trays by crane.

To ensure the retaining bank being founded on hard shale, the mud, silt and decomposed shale was removed by dredger and the foundation covered as soon as practicable with a 3 ft layer of stone rubble which was later brought up to such depth as did not interfere with the driving of the landward row of piles.

Due to the closing of the Suez Canal, some of the dredging plant, but not the dredger, had to be brought to Mombasa via the Cape, involving an extra charge, but no time was lost on this account as the plant arrived shortly after the dredger had completed a refit. Dredging started at the beginning of June and all dredging was completed by the middle of September, 1957.

As the concrete piles had to be driven into shale of varying degrees of hardness, all piles were fitted with a substantial rock shoe. Penetration into the shale varied from 10 ft to 20 ft.

Apart from a floating pile driver the contractors provided two pile driving frames, one of 10 tons and one of 6 tons capacity, which traversed a pile frame carriage which itself travelled longitudinally along the berths on a track supported by temporary steel, reinforced concrete and later timber piles. Pile driving occupied 15⅓ months, during which time 1,776 piles were driven.

The pile driving was closely followed by the concrete superstructure and decking which was completed six months after the last pile had been driven. The longest operation was placing fill to form the reclamation area. The landward slope of the rubble retaining bank was first trimmed to profiles and then provided with a graded stone filter consisting of a 9 in layer of stones (3 in down to 1 in) followed by a further 9 in layer of stone (1 in down to grit). This filter extended from 3 ft below low water to 1 ft above high water. The filling up to level +14·00 consisted of clayey sand obtainable from a railway cutting behind the westernmost berth and above this level filling material was obtained from trimming a shale cliff behind Berths 11 and 12. It is considered that the filter proved satisfactory in preventing the loss of filling due to tidal flow through the rubble bank as no undue settlement has been reported.

Berths 11 and 12, which are being brought into immediate use, are fitted with vertical fenders comprising four interlocked Peine piles driven into the shale at 60 ft intervals and cushioned by 12 in Goodyear rubber fenders with intermediate fenders at 20 ft intervals. These berths have 126·2 lb per yd FB section heavy dock rail on both crane and railway tracks.

At the back of Berth 12, a reinforced concrete transit shed, 500 ft long by 200 ft, and consisting of three bays, was constructed by the contractors.

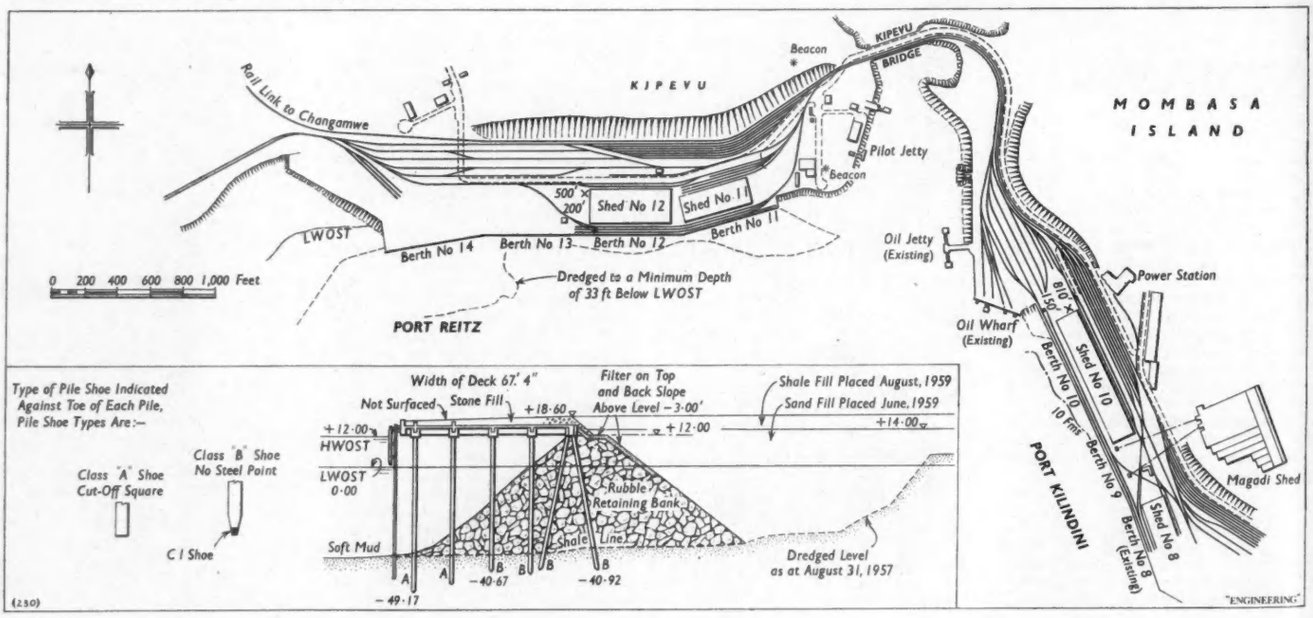
It is not proposed to equip Berths 13 and 14 yet awhile and at present they provide a very useful "idle" berth.

The berths, which have been built for the East African Railways and Harbours authority, were officially opened by the Governor of Kenya and Uganda on 3 February, 1961. The cost of the four berths, including the reinforced concrete transit shed, amounted to £2,138,000.

Consulting engineers: Coode and Partners, 2 Victoria Street, London SW1.
Contractors: Christiani and Nielsen, Limited, Tufton Street, London SW1, with J. L. Kier and Company Limited, 7 Lygon Place, London SW1.

Mombasa Harbour from the west with the new transit shed on Berth No. 12 shown nearing completion.

Location of the new berths in Mombasa Harbour and a typical cross-section through the new quay wall, showing the rock filter at the back of the wall.



Use and Control of Vegetation in Civil Engineering

In the more humid regions of the tropics vegetation can present a serious problem to the civil engineer. If left unchecked, it can block drainage channels, break up roads and, by rank growth, even disrupt driving vision; and it can also cause the reinfestation of clean agricultural land. On the other hand, vegetation often plays a more positive role, helping to counter erosion by wind and rain, as well as abrasion by traffic, and improving road safety and amenity.

In a new Road Research Technical Paper, No. 52, *The Use and Control of Vegetation on Roads and Airfields Overseas*, by K. E. Clare, the results are given of a survey made by the Road Research Laboratory of the Department of Scientific and Industrial Research to discover which types of vegetation are useful and which present difficulties. In compiling the report, the Laboratory had the help of 33 overseas territories. Information was also gathered about methods used in maintaining road verges, and costs are given. The paper, which contains a bibliography of 67 items, is published for DSIR by the Stationery Office (3*s* 6*d* net).

Following the survey it is believed that rainfall, geographical location, existing control and drainage are the major factors affecting the vegetation régime at any given site. Because of the wide variety of names that have been given to particular plants, an appendix to the paper gives both the Latin and local English names for the more common botanical species.

Methods of controlling vegetation on roadsides have, it was found, been borrowed from agricultural practice. Methods relevant to roadworks and discussed in the paper are:—

(i) Mechanical methods—(*a*) hand cutting or hoeing, (*b*) mechanical cutting, and (*c*) burning.
(ii) Biological methods—(*a*) grazing and (*b*) use of parasites.
(iii) Chemical methods—(*a*) non-selective herbicides and (*b*) selective herbicides.

It was found that hand cutting was still the most widely used method, though in many territories it was being supplemented or superseded by mechanical methods. There is, however, a very widespread interest in chemical methods involving spraying. The Agricultural Department in Cyprus is reported as envisaging the following advantages of controlling roadside vegetation by chemical control:

(i) It may be cheaper than hand control.
(ii) The soil is not disturbed as in hand control, thus decreasing the liability to erosion.
(iii) Livestock can graze the improved pasture.
(iv) Reinfestation of adjacent land may be reduced.

It is pointed out that any weedkillers must be non-toxic to livestock because of the prevalence of verge side grazing; in some areas it is also essential that the materials used shall be harmless to people because the pedestrians walk barefooted. In his foreword, the director of the Laboratory says that it is the intention of the Road Research Laboratory to encourage the use of chemical controls wherever possible, and to this end discussions are in progress with interested road authorities and the section of the chemical industry involved.

The economic data collected suggest that expenditure involved in vegetation control is not large by civil engineering standards, so the subject is placed on the fringe of road and airfield technology. On the other hand it is clear that small but useful developments are continually taking place, both within the agricultural industry and on the initiative of public works departments. Given proper control, vegetation can greatly assist with preventing erosion of the road haunches, side ditches and the side slopes; it may provide better running surfaces than the bare soil; it can improve foundations by stabilising the moisture content; it can improve road safety by providing crash barriers and dazzle screens, and by relieving driving monotony; and final it can have an aesthetic value by improving the scenery.

Kyna Hydro-electric Power Project in Bombay State

The hydroelectric project at Kyna, in the Bombay region of eastern India, is being developed in three stages. The first stage comprises a rubble concrete dam across the Koyna river built to part height and an underground power house fed by a water conduit system taking off from the Koyna lake to generate 240 MW at 60 per cent load factor and producing 1,262 million kWh a year. It includes a double circuit 220 kV transmission line to Trombay where it will be connected to the Tata power system.

Progress on the main components of the project at the end of 1960 are as follows. Excavation of overburden and rock has been accomplished and 23·70 million cu. ft of concrete has been put in place. Underground excavation has also been completed and concreting there is in full swing. Concreting in the head race tunnel and in the tail race tunnel are also being advanced. Excavation for the power house, including the valve house and transformer hall, has been completed. By the end of last year, the first two turbines had been installed and the third one erected. Erection work had started on the first generator. Electrical and mechanical equipment are being received at site according to schedule. Work is well in hand with the stub-setting in 565 locations out of 746. Towers have been erected on 364 locations and a beginning made with stringing.

The first generating set of 60 MW is to be commissioned in mid-October and the other three sets, each of the same capacity, at intervals of six months thereafter. The expenditure incurred up to the end of last December was Rs26·27 crores (£19 million) which is 58 per cent of the estimated outlay on the project. The entire scheme is to be completed late in 1963 when the power output will be 500 MW.

The first load of 60 MW will be transmitted mainly to the Kodhapur region. The second 60 MW will serve the needs of Sholapur district and the third, of Sangli, Satara and Kolaha. Power will be supplied for industrial, domestic and other purposes, including the central basic chemical plant being commissioned at Kharpada near Parvel and the adjacent fertilizer factory. The Bombay Government are considering earmarking some power load of the third phase for the electrification of the new Konkan Railway line between Diva and Apta. The final phase of this scheme will supply Koyna power to the Chiplun-Ratnagiri region.

Working Stresses and Stress Grading for Laminated Timber

Lack of data on strength properties has in the past prevented full advantage being taken of laminated timber in structural work, according to a new publication from the Forest Products Research Laboratory. It is entitled *Working Stresses for Structural Laminated Timber* and is by W. T. Curry. No. 15 in the Special Report series on forest products research, it is published for the Department of Scientific and Industrial Research by the Stationery Office (4*s* net).

Because of this lack of knowledge, the stress values for design have tended to be low and often costly, and unnecessary restrictions have been imposed on the quality of the timber used. The report now published gives basic stresses for a number of common wood species and from an investigation into the incidence of knots and of their effect on strength properties, factors have been determined which enable working stress values appropriate to laminated timber to be derived. The relevant British Standard Code of Practice, CP 112 (1952) " The Structural Use of Timber in Buildings " deals exclusively with the properties of sawn timber and does little to encourage the use of laminated timber where, given proper selection, higher stresses may be employed. The code is, however, under review and revision in respect of the use of timber for laminated sections is expected. As was recently pointed out by Mr. W. A. Chugg of the Timber Development Association (see " Can Glulam Stresses Be Increased Safely?," ENGNG., 28 April '61, p. 590) before full advantage can be taken of the higher stresses that are permissible, adequate inspection has got to be evolved by the timber industry so that satisfactory stress grading can be carried out. Appendix A of the new report lists some rules for stress grading timber based on the research described in the report.

Of the factors influencing the strength of a piece of timber (as compared to the strength of ideal piece of the same species) the size and location of knots and the slope of the grain are the most important. Grading must not be carried out until the specimens have been dried to a moisture content not exceeding 15 per cent. The only operation permitted on the laminae after they have been graded is that of planing, and even then the quantity that may be removed is strictly limited.

Laminae containing decayed wood shall not be used, though blue stain may be permitted if its effect on appearance is acceptable. Checks, shakes or splits that make an angle of less than 45° with the wide face shall not be permitted. Wanes may be permitted if small . . . small pitch streaks or resin ducts may be acceptable . . . material that is excessively resinous for the species should be rejected . . . the slope of the grain should be measured over a sufficient length to determine the general slope, disregarding small local deviations. In estimating the ratio of knot cross-section to the cross-section of the laminae, no distinction may be made between live and dead knots and knot holes shall be assessed as knots . . . as most knots are of an irregular shape, their sectional area must be estimated from a consideration of the direction of the growth rings and of the appearance of their exposed surfaces.

Three grades of timber are then recognised for which the slope of grain and knot ratios are as follows:—

Grade of Laminae	A	B	C
Slope of grain	1 in 18	1 in 14	1 in 8
Knot ratio	one-tenth	one-quarter	one-half

Limitations are also given on the permitted width of cylindrical knots in given widths of laminae for each of the three grades.

The above extracts from the suggested rules for stress grading are not meant to be complete and reference should, of course, be made to the original text.

Army Fire Power: Improved Small Arms

From small arms to anti-tank missiles, the evolution of army weapons is towards increased weight and effectiveness of fire, by means of automatic loading, closer control and greater penetration.

By R. M. Ogorkiewicz, M.Sc.(Eng.), A.M.I.Mech.E.

DEVELOPMENT of military equipment is inevitably shrouded in secrecy but the paucity of official information causes it to receive even less notice than is justified and far less than it deserves. This is particularly true of Army weapons, where the veil of security extends to items which have long gone out of service. In the circumstances, it is difficult for the non-specialist to perceive even the broad course of weapon development and an impression is apt to be created that little is happening in this field.

At the same time, the Army is robbed of some of the wider interest which its problems merit and of the potential public support which it needs, particularly at this difficult stage of its history. In consequences, it is all the more interesting and important to examine some of the Army weapons which may be cited and to consider them against the background of military developments at large.

Fig. 1 Family tree of the Sterling sub-machine gun: (top to bottom) German Schmeisser; the Lanchester, as used by the Royal Navy during the Second World War; an early development model; and the production version.

Fig. 2 FN 7·62 mm self-loading rifle as used by British Army. Originally Belgium designed, it has been adopted by several Commonwealth and NATO countries but not by the United States.

PISTOLS AND SUBMACHINE GUNS

Army weapons range from small arms to guided missiles with nuclear warheads. One extreme of this range is represented by the 9 mm FN Browning Pistol Mark 2, which was adopted in 1957. This Canadian-made Model 1935 Belgian Browning automatic pistol is by no means a new weapon but it represents a well-proved design and its adoption at least constitutes a move beyond the revolver, which has been long abandoned by practically every other army. It is chambered for the 9 mm rimless cartridge which was introduced in 1902 in the German Luger pistol and which has since become the world's most widely used pistol and submachine gun cartridge.

Significantly, even the Soviet Army has gone over to a 9 mm cartridge, after many years of using 7·62 mm pistol ammunition, for its new PM (Makarov) and APS (Stechkin) pistols introduced since the Second World War. But, although the general characteristics and muzzle velocity of the new 9 mm Soviet pistol cartridge are similar to those of the international 9 mm Luger or Parabellum cartridge, its 94-grain bullet is lighter and it is not interchangeable with the Luger or any other cartridge. The United States Army, with its M1911A1 pistols chambered for the 0·45 calibre ACP (Automatic Colt Pistol), is now almost the only one not to use 9 mm pistol ammunition.

The current, Sterling Mark IV, or L2A3, submachine gun, the evolution of which may be gathered from Fig. 1, replaces the earlier Stens, and, like the latter, is also chambered for the 9 mm Luger cartridge. As others in this category, it is a simple blow-back operated weapon and its principal advantage over earlier designs is its compactness, for it measures only 19 in with the butt folded, and good balance, obtained at the expense of having its 34 round magazine project to the left of the body.

However, in compactness and balance the Sterling now has a competitor outside Great Britain in the latest refinement of this type of weapon, the Israeli 9 mm Uzi submachine gun, which has its magazine inserted through the pistol grip. Among others, the Uzi has been adopted recently by the German Army, which together with the British and other West European armies, has a requirement for a submachine gun using pistol ammunition for fighting at close range.

In contrast, both the Soviet and US armies have abandoned submachine guns since the Second World War. However, one of the two new Soviet pistols, the APS, is capable of full, as well as semi-automatic, fire and, being provided with a shoulder-stock holster, of the type once popular with the 1896 Mauser pistol, it can fulfil a role somewhat similar to that of a submachine gun.

RIFLE AMMUNITION

Otherwise, neither the Soviet nor the US Armies now have a weapon between the pistol and the rifle. The gap is less marked in the former case, not only because of the APS machine pistol, but also because the new Soviet rifle cartridge is less powerful than the 7·62 mm NATO cartridge for which the American rifles are now chambered. The new Soviet cartridge, designated as Model 1943 though introduced considerably later, is also of 7·62 mm calibre but it is shorter and lighter. Thus, it is only about 2¼ in long, compared with 2·8 in for the NATO cartridge, and it has a 122-grain bullet with a muzzle velocity of 2,329 to 2,411 ft per second, compared with 165 grains and 2,780 ft per second.

It is interesting to note that the bullet weight and muzzle velocity of the new Soviet cartridge are not very different from those of the British 0·280 in (7 mm) ammunition brought out after the war in conjunction with the EM-2 rifle, the actual figures being 139 grain and 2,400 ft per second. Moreover, the general characteristics of the EM-2 rifle resemble those of the AK (Avtomat Kalashnikov) automatic rifle, which is one of the three Soviet weapons chambered for the 7·62 mm Model 1943 cartridge.

At the time of its appearance, in the early fifties, the 0·280 British cartridge was strongly criticised in the United States as not powerful enough and it was eventually abandoned together with the EM-2 rifle in favour of the American T65E3 round which was adopted in December, 1953, as the 7·62 mm NATO round. The latter is about 10 per cent lighter and 0·55 in shorter than the hitherto standard United States 0·30-'06—a particularly long round—but it has the same bullet weight and muzzle velocity, achieved by the use of a more powerful ball powder.

The advantage of the lighter and less powerful rifle ammunition, such as the Soviet 7·62 mm Model 1943, or the German short 7·92 mm which preceded and probably inspired it, is that it enables the individual rifleman to carry more rounds and makes for lighter and more manageable automatic rifles. Its disadvantage is inferior accuracy at longer ranges. In consequence, it is generally considered inadequate for snipers' rifles and machine guns, although the Soviet Army uses it in its new RPD light machine guns.

It is also worth noting that the more powerful 7·62 mm ammunition adopted recently by the British and other NATO armies is essentially a modified form of a cartridge evolved towards the end of the last century, when long-range volley fire was still in the vogue. Since then the same ammunition has served well in machine guns but it is by no means universally regarded as best suited to the infantryman's needs. In particular, its weight and calibre are thought excessive and the 0·280 British cartridge is still held by some to represent the optimum solution.

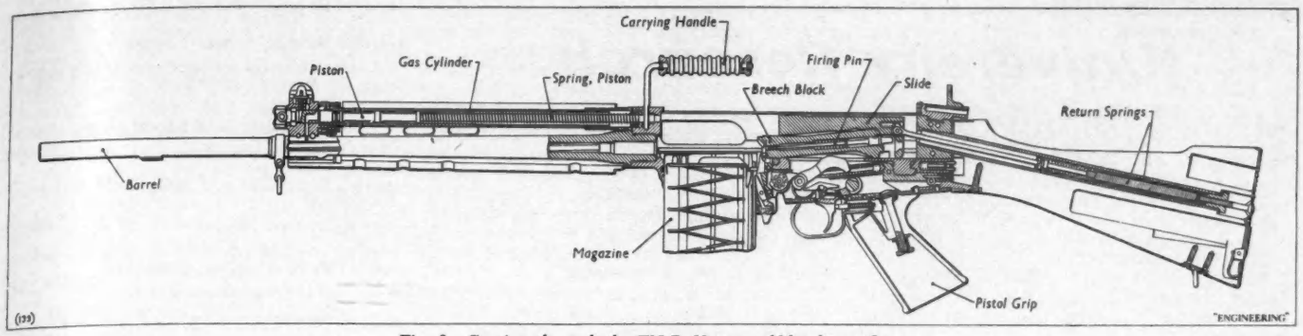


Fig. 3 Section through the FN 7·62 mm self-loading rifle.

Even further reductions in calibre have now been considered in the United States. Smaller calibres than the current 7·62 mm have already been used before the turn of the century when, in the process of the gradual reduction of the calibre of infantry weapons from the half-inch muzzle loaders, several countries arrived at 6·5 mm rifle ammunition; but before the Second World War this was superseded by the now common larger calibres.

However, the contemporary 6·5 mm cartridges did not differ to any significant extent in muzzle velocity from those of the larger 7 to 7·92 mm cartridges, whereas what is now being considered in the United States is not only a further reduction in calibre, to only 0·22 in, but also a very considerable increase in muzzle velocity, to well over 3,000 ft per second.

RIFLES

The development of high-velocity 0·22 ammunition has been followed by that of compatible lightweight automatic rifles, and two models, evolved in 1957, have already been demonstrated: the 0·224 Winchester and the AR-15 developed by the Armalite Division of the Fairchild Engine and Airplane Corporation.

Other attempts in the direction of lighter rifles include departures from conventional materials. Thus, the AR-15 makes use of aluminium alloy for its receiver and other external parts; the body of its 25-round magazine is also of aluminium alloy and a similar magazine has been used in its larger calibre forerunner, the 7·62 mm AR-10. The latter has also an aluminium-alloy barrel with a stainless-steel liner and foamed-plastic forearm and stock.

A somewhat different solution has been adopted in the Remington Nylon 66 sporting rifle which has a nylon stock. Plastic rifle furniture has also been tried in this country, but without showing any marked advantage, even with regard to weight, over wood which continues to be preferred by the user.

Whatever future development may bring in infantry small arms, the British Army is likely to use its current 7·62 mm FN self-loading rifle for some years to come. This rifle is shown in Fig. 2 and in section in Fig. 3. Belgian-designed it has been adopted also in several Commonwealth and NATO countries but not in the United States. It was tried there under the T48 designation but preference for native products led to the adoption of the T44E5, a lightened 7·62 mm version of the earlier M1 Garand semi-automatic rifle, standardised in 1957 as the M14.

To the extent that it is only a development of the Garand, the American M14 rifle represents less of an advance than the adoption in 1954 of the FN by the British Army, which until then still only used bolt-action rifles. The essential features of the FN are not very original, however, for it is a gas-operated rifle of conventional design. Indeed, not only has it none of the originality and compactness of the British EM-2 rifle, but its essential features have been tried before, notably in German and Russian weapons.

One of the consequences of the adoption of the FN rifle is that it restores, to some extent, the importance of the individual rifleman. At any rate, the rifleman has regained some of the ground lost in the past to light machine guns, such as the Bren. Or, perhaps, it would be truer to say that the magazine-fed light machine gun has lost a good deal of its relative importance since the general adoption of self-loading or automatic rifles with 20-round magazines.

The least affected by this development are the United States, where the cult of the individual rifleman has persisted and where less emphasis has been placed in the past on crew-served automatic weapons than in most other countries.

MACHINE GUNS

Analyses based on the Korean War have shown, however, how few men make effective use of their individual weapons under the stress and conditions of modern battle and such findings would question further emphasis on rifles such as the M14 or the FN, as compared with team-operated light machine guns.

The machine guns used by the British infantry are still the light magazine-fed Bren, which was introduced during the thirties and which is now being rechambered from the old 0·303 rimmed ammunition to the 7·62 mm NATO cartridge, and the heavy belt-fed Vickers, which dates from before the First World War and is by far the oldest machine gun used by any major army.

But it is no secret that a new machine gun has been undergoing trials. This is the Belgian-designed belt-fed FN which has already been adopted by the Swedish, as well as Belgian, armies and which can be used with a bipod as a light machine gun or from a tripod as a medium machine gun, as illustrated in Fig. 4.

It would, therefore, fulfil the same role as the M60 general purpose machine gun adopted recently in the United States and, in general, follows the pattern set during the 1930's by the German MG-34, the precursor of the current belt-fed dual-purpose machine guns. The adoption of this type would also imply an end to the existence of the two earlier categories of light and medium machine guns and a simplification of the infantry weapon system.

The FN machine gun, like the American M60 and the Soviet RPD, is gas operated, as well as being belt fed. In fact, there has been a general trend towards gas-operated machine guns which are somewhat less critical with regard to their functioning and by comparison easier to develop.

Recoil-operated machine guns have not disappeared, however, and the new American 7·62 mm M73 tank machine gun is of this type. This gun, developed since 1956, has a very short action to ease installation in armoured vehicles and is intended as a replacement for the M1919A4 0·30 Browning machine gun, which has been used successfully for many years in American tanks, and, since the unlamented disappearance of the 7·92 mm Besa, also in several British armoured fighting vehicles. Future British armoured vehicles will presumably follow the American example and incorporate the M73 in place of the Browning.

The Americans have also developed a new 0·50 tank machine gun, the M85, to replace their earlier 0·50 Brownings. This too is a recoil-operated weapon fed by an open-link disintegrating link but it possesses an unusual feature in its two rates of fire which can be selected by means of a change lever: a cyclic rate of 400 rounds per minute for fire against personnel and 1,050 against aircraft. In contrast, the British Army has no requirement for this type of large-calibre machine gun, which is widely considered far too powerful against personnel and of doubtful value against other types of targets.

There appears to be a distinct requirement, however, for a larger automatic weapon for use on and against armoured personnel carriers and other light armoured vehicles which are now widely used. This could be a high velocity 20 to 30 mm automatic gun and it is relevant to note that some of the new light armoured vehicles of the German Army are armed with 20 mm automatic guns which have a muzzle velocity of 3,440 ft per second.

A second article by Mr. Ogorkiewicz, to be published shortly, will deal with trends and developments in tank and anti-tank guns.

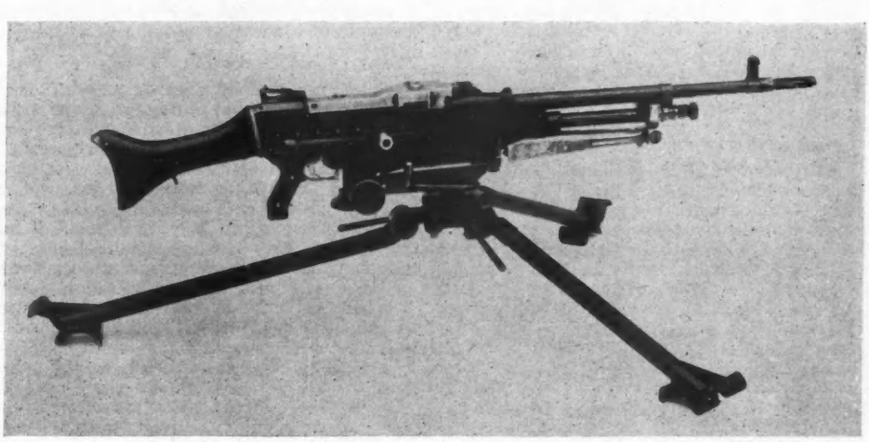


Fig. 4 Belt-fed 7·62 mm FN general-purpose machine gun mounted on a tripod.

University Research

More than three-quarters of a million pounds is to be contributed by the Department of Scientific and Industrial Research towards the cost of a new nuclear physics research centre at Oxford University. This sum constitutes the largest single grant ever made by the Department and will provide a particle accelerator of novel design, with which Professor Denys Wilkinson, F.R.S., Professor of Experimental Physics at Oxford, proposes to undertake an extended programme of long-term research on nuclear structures.

In addition, the National Institute for Research in Nuclear Science will carry out the design of part of the accelerator at a cost to the Institute of some £200,000. The Univeristy Grants Committee are contributing £75,000 towards the cost of building the first stage of the centre, thereby bringing the total government support for the project to approximately £1 million.

Commencing Construction this Year

The centre will be built near the Clarendon Laboratory, on the triangle formed by Keble, Banbury and Parks roads, in four stages over the next ten years, and will eventually include research and teaching laboratories, offices, a library, and a lecture theatre capable of seating 800 persons. It is intended that this lecture theatre, which will form part of an extension to the Clarendon Laboratories, shall be available for general university use. There will also be a new theoretical physics building for the use of post-graduate students.

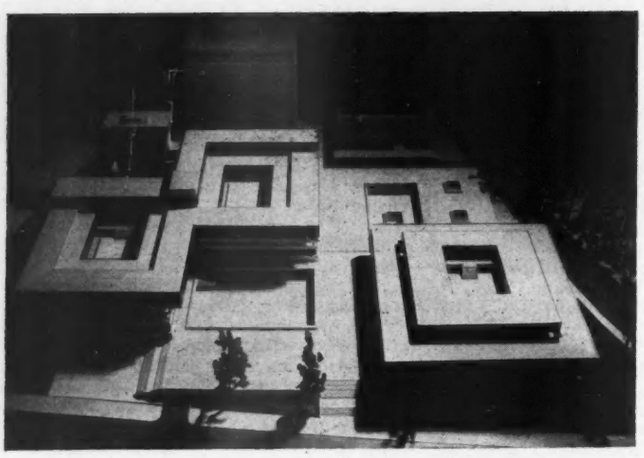


Fig. 1 Model showing the general layout of buildings for Oxford University's new nuclear physics research centre.

When erected, the nuclear physics centre will be the third new science structure on the Keble Road triangle. The first, the new metallurgy laboratory, costing some £100,000, was opened a year ago, and the other is the nine-storey engineering laboratory now in the course of construction. Work on the first stage of the nuclear research centre is expected to be commenced this year.

Combined Energy of 20 MeV

The specially designed equipment for the centre will comprise an 8-10 MeV Van de Graaff vertical electrostatic generator, to be designed and constructed by the Electrostatic Generator Group of the National Institute for Research in Nuclear Science at the Rutherford Laboratory, Harwell, together with a 12 MeV Van de Graaff horizontal tandem electrostatic generator, to be purchased from the High Voltage Engineering Corporation of America.

The vertical generator from the NIRNS will be able to be used either as a high-intensity generator in its own right or as a high-energy injector in conjunction with the 12 MeV, horizontal machine to give a combined energy of 20 MeV, thereby enabling Professor Wilkinson's teams to carry out experiments throughout the whole range of nuclei. It will also allow several important types of investigation to be undertaken into those light elements which required the use of very high energy. However, for a great deal of work, requiring only relatively low levels of energy, the two machines will be operated individually. The accelerator is regarded as being the first of its type in the world.

Together, the two generators will occupy some 19,000 sq. ft of floor space in the centre's nuclear physics laboratory; the horizontal machine being housed in the basement and the vertical machine in the tower. This arrangement will leave an additional 6,000 sq. ft for shielding the equipment, and maintenance and experimental work.

Equipment Available for other Institutions

Equipment of this nature and cost is regarded by all concerned as a national asset and, while provided primarily for Professor Wilkinson's research programme, the machines will be available to research personnel outside the university. In this connection Professor Wilkinson has stated that, at any rate where problems of research importance arise, scientists from other centres and from private firms will be able personally to conduct investigations. These facilities will be available either by arrangements made direct by the parties concerned, or at the request of the Council for Scientific and Industrial Research.

In considering outside requests for the use of these machines, the university and the Council will be advised by an Oxford University Accelerator Panel, which will be appointed by the Council. The panel will include members nominated, respectively, by the University, the University Grants Committee and the National Institute for Research in Nuclear Science.

Constructional Details

The Department of Scientific and Industrial Research will also be contributing towards the running expenses and, in order to make the best possible use of the equipment, it is planned that the research staff and students shall eventually use the generators on a three-shift basis.

The illustration (Fig. 1) of a model of the new centre shows the general layout of the differing buildings and how these buildings are related to one another by landscaped terraces and interior courts arranged at various levels. The buildings are to be constructed in reinforced concrete, with an external finish in concrete, using Portland stone as the aggregate, tooled to give a textured surface. The aggregate and finish have been chosen so that the buildings shall weather well. Glazing, where unprotected from sun by overhangs, is to be in grey heat-absorbent glass. The consulting engineers are Ove Arup and Partners, London W1.

Harwell Reactor School Courses

A list of the future courses to be held at the Reactor School, Harwell, is given below. Further information or application forms may be obtained from: The Manager, The Reactor School, Atomic Energy Research Establishment, Harwell, Berkshire.

OEEC course (restricted to OEEC nominations)	10 to 21 July
Standard Course No. 23:	
Part I Technical College	18 Sept. to 17 Nov.
Part II Harwell }	22 Nov. to 2 Feb.
Part III AEE, Winfrith }	(1962)(provisionally)
Senior Technical Executives' Course No. 13	11 to 22 Sept.
Control and Instrumentation of Reactors Course No. 7 (provisional) ..	25 Sept. to 6 Oct.
Radiation Protection Course No. 5 ..	25 Oct. to 30 Jan. (1962)

New Element Discovered

A team of scientists at the Lawrence Radiation Laboratory, University of California, have discovered a new element. The element 103 isotope is the first to be discovered solely by nuclear methods, since the experiments were conducted with the heavy ion linear accelerator (HILAC). The element was created by bombarding a target of three millionths of a gram of Californium with boron 10 or boron 11 nuclei at 70 MeV. It is thought to have an atomic weight of 257, but further research is necessary to establish this.

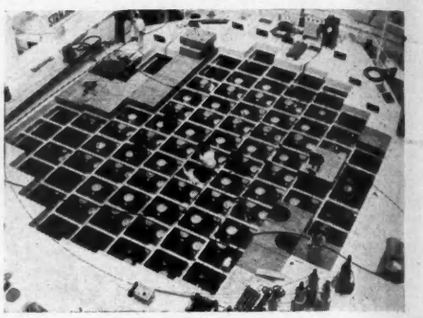


Fig. 2 Pile cap of the No. 1 reactor at Bradwell.

Reactor Notes

Low Temperature Project: Industrial organizations are being invited by the USAEC to participate in a demonstration of a low temperature process steam project planned for initial operation in the winter of 1964-65. It would be a 30-40 MW(t) reactor with steam pressures from 15 to 200 lb per sq. in. This type of reactor is suitable for industrial operations where large quantities of heat are required.

Wyoming Given the "All Clear": Following an investigation by the USAEC, on April 26, the University of Wyoming was ordered to shut its reactor down because it was found unattended by a licensed operator. The suspension has now been removed since further investigations revealed no similar instances previous to this, and an assurance that no further lapse would occur.

Bradwell Operation: The first reactor of the nuclear power station at Bradwell is expected to be in operation by August of this year, and the second reactor will follow about six months later. The total cost of construction and the initial fuel charge will be approximately £58 million. Fig. 2. shows the No. 1 pile cap.

Australian Project: With the aid of British assistance, the Australian Government is investigating the possibility of setting up a 500 MW nuclear power station at an estimated cost of £49·6 million. Possible sites for the station are in South Australia or the Cape York Peninsula, Queensland.

Egyptian Interest: Long range plans for a 100 MW nuclear plant costing up to £12·1 million are being considered by the Egyptian Government. It will be built at Fayoum, el Alamein or in the Hof Valley.

Companies

Success Pattern of a Pioneer

BOUNDING ahead in its group turnover, forming a series of manufacturing and development agreements with other leading companies, and turning towards new fields of application for automation, the ELLIOTT-AUTOMATION group, a text book example of growth and expansion, are accelerating the rate of their advance.

Turnover amounted, in round figures, to £20 million in 1960, a 25 per cent increase on the £16 million of the year before. Understandably the Elliott annual report speaks of strain on the engineering and manufacturing resources. The number employed in the United Kingdom has now risen to almost 12,000 and a new works is being built alongside the Rochester, Kent, premises of the company.

The order book, despite the rising turnover, has been steadily lengthening over the year and further expansion is predicted by Rudolph E. F. de Trafford, the Elliott chairman. Increasing momentum in the demand for automation equipment, an essential part of the Elliott credo for many years, is more and more apparent and the company expect to reap a growing benefit from their preparatory work. This does not mean any reduction in the heavy research and development expenditure as techniques develop and the scope of the company's activities broadens.

Income Incentives

Elliott-Automation are one of those fortunate companies able to look back with favour upon two separate features of the last Budget. As a pioneer concern in fields of advanced engineering and scientific development they employ an unusually high proportion of highly rewarded technological and executive staff. The company accordingly was particularly happy to see the relief given by the raising of the surtax level, enabling all these personnel to enjoy a greater proportion of their income. And for all the doubts that have been raised by the way in which the Chancellor of the Exchequer took up the payroll tax idea, Elliott-Automation are, of course, favourably impressed that the payroll principle, at least, has been accepted, with all that this implies for the broader application of automation and its associated methods and equipment as a nationally backed policy.

A great deal of the company's effort has so far gone into automation in such process industries as chemicals and oil, and into data processing. Attention is now turning to what is known as mechanical automation. It seems probable that much of the group's new growth will lie in this direction, and that for the companies who move swiftly with these developments there will be parallel advantages in economy and speed of production, to take only two factors.

Elliott have become licensees of JERVIS B. WEBB, of Detroit, Michigan, thus being given access to advanced methods in big scale materials handling, which now includes electronically controlled conveyor systems. There is a rapid build up of orders in this field. Agreement has also been reached with WARNER AND SWASEY, of Cleveland, Ohio, a noted machine tool company who have produced electronic machine tool control systems of outstanding quality and price economy.

More domestically Elliott are closely involved in the mechanization of the Post Office, providing the coin boxes for direct trunk dialling and also the technically advanced equipment for automatic mail handling.

In the high vacuum field Elliott have formed a joint company with E. LEYBOLD'S NACHFOLGER, of Cologne, who have a world name in this work. The joint enterprise is to develop the Commonwealth markets for the products and know-how of the two parent firms, and of the Leybold Nachfolger associate, LEYBOLD HOCHVAKUUM-ANLAGEN, in vacuum pumps and specialised plant, i.e., those for coating and impregnating.

Another of Elliott's associations with an outstanding overseas concern is the venture in microwave tubes with LITTON INDUSTRIES, of Beverly Hills, California, USA. Even before this new link the company had built up a considerable export business in microwave valves to the United States. Still on the same side of the Atlantic, an agreement has been reached with ROTRON CONTROLS Corporation, of New Jersey, for the exploitation of their flowmetering equipment in the Commonwealth and in Europe.

Elliott have a majority holding in each of these joint ventures.

The Fascination of "Who Owns Whom"

With the stock market valuation of companies discounting the future a very long way ahead and with some very high level doubts on the present state of the market for successful take-over operations, a good deal of attention has been swung, at least in manufacturing industry, from who is buying whom to the more contemporary question, who is buying subsidiaries in the European Common Market.

Who Owns Whom, the cumbrously titled but endlessly fascinating volume whose 1961 edition (its fourth) has now appeared, has widened its last year's coverage of the Common Market to three new sections, covering United Kingdom subsidiaries in Western Europe, UK subsidiaries in the United States, and US subsidiaries in Western Europe.

Whatever the current view of take-overs and mergers, *Who Owns Whom* clearly shows how ownership and control goes on changing at a pace not formerly associated with a period of only slowly rising national output. Section One of the 1961 edition, which shows UK subsidiary and associate companies with UK parent and associate companies, contains some 19,000 subsidiaries and associates. Since the 1960 edition 4,000 entries have been added and 1,000 taken out. This net increase of 3,000 compares with one of 1,000 in the previous year and underlines the ferment still going on in the change of direction in companies and the formation of others.

Future editions of the work may well show the carrying into practice of the forecast made last November by Per Jacobsson, managing director of the International Monetary Fund, when he said that a tendency would soon develop for European capital to be invested in the United States and other continents. For the moment the heavyweight in overseas capital investment is the United States with planned expenditure by American companies in Britain running slightly ahead of the level of US companies' spending in the European Common Market. This is a situation which United States estimates of the economic realities of Europe's future may tend to put into reverse, but for a long time ahead it seems likely that dollar investment in Britain per head of the population will be far ahead of that in the Common Market.

Later this year O. W. ROSKILL AND COMPANY (REPORTS) Limited, 14 Great College Street, London SW1 who produce *Who Owns Whom* (price 6 guineas) are to bring out a companion directory, which will be a continental edition.

This new work will give parent, associate and subsidiary companies in selected countries. Foreign as well as national concerns will be entered.

Flying After the Executive Business

Some notable engineering concerns have been founded on providing for the rest of industry the product or service which has been found to answer the special need of the company who have gone on to exploit their advantage.

Behind the careful assessment of the market for light business and personal aircraft and their ability to provide for it, lies the experience of the PRESSED STEEL company in 18 months of operating two executive aircraft. With factories at Cowley, Oxford, near Swindon, Reading, Glasgow and Swansea, and subsidiaries in Birmingham, Nottingham, Bedford and Brussels, the Pressed Steel executives have plenty of getting around to do. They know, too, that there is almost no end to the list of companies in groups just as numerous or with associates as widely spread.

Hence the decision to set up BRITISH EXECUTIVE AND GENERAL AVIATION Limited (BEAGLE), and through this company to acquire AUSTER AIRCRAFT Limited and the aviation interests of F. G. MILES Limited. It is planned to design and produce new executive and light aircraft for the home and export markets and already the first BEAGLE executive aircraft has been shown, in model form, as far afield as the British Trade Fair in Moscow. A new control tower has been built by PS at Oxford Airport, Kidlington (*inset*).

Some of Pressed Steel's longer established divisions endured rather heavy going last year. The final result was a slip in the profits, after tax, from the 1959 figure of £2,461,000 to £1,872,000.

After some hesitation in July, followed by recovery in August and September, the motor car body division found demand falling off swiftly from October on, producing short time working and leaving only the tool making capacity fully employed. Beginning in February and increasing in pace, there has since been a general recovery in demand, returning both the Cowley and Swindon factories to full time working.

The PS expansion programme is being carried through as planned. At Swindon a new building of 723,500 sq. ft is approaching completion. Linwood, near Glasgow, is to have a new 500,000 sq. ft building turning out painted and trimmed motor bodies.

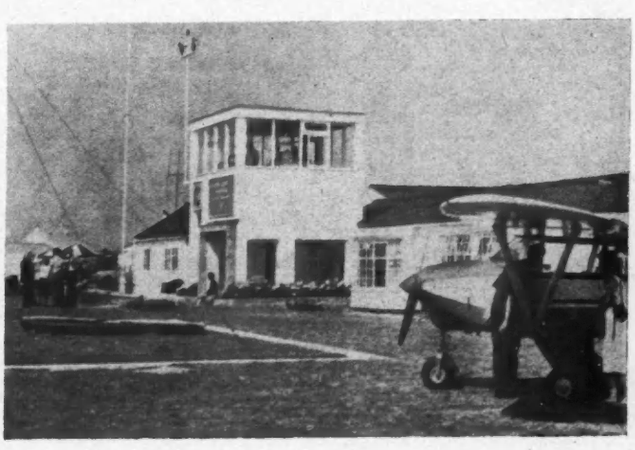
Overall expenditure on capital projects will reach some £14 million. In addition, substantial sums of working capital will be needed as production gets under way. Since Glasgow is one of the Government's designated areas for development PS were able to go, successfully, to the Board of Trade with an application for financial assistance for the Linwood scheme.

For three reasons sales of Prestcold refrigerators did not come up to the levels of 1959, although there was an increase in exports. The reasons: the effect of Government hire purchase restrictions, the bad weather of most of the summer, and the impact of 180,000 imported foreign refrigerators. The commercial side of the refrigeration division was rather happier. Its sales were satisfactorily above those recorded in 1959.

Better performance is hoped for in the domestic refrigerator field this year. Some hope is entertained that the impact of foreign imports will be lessened by the customer's realization that it is important to have a good service organization behind his appliance.

Summing up, the Pressed Steel chairman states that the start of the current year has not been propitious. Without expecting a return this year in the motor body division to the high levels of the first half of 1960, it is hoped that improvement will continue and a more profitable level of operations be reached in the remainder of the year.

Results for the year will be largely dependent on the volume of output that can be maintained between now and the year's end.



Uses of Lightweight Expanded Plastic

Expanded plastics are of interest in light engineering so long as they are used with caution. Here are three British applications.

So long as working temperatures will not rise above around 65° C, two inexpensive cellular plastics are worthy of attention. With this limitation in mind (and characteristics can be varied slightly with composition) it seems fair comment to forecast an increasing market for these materials—and many will be in the lighter forms of engineering.

British Plastics in their annual review of the industry (see issue of Jan. '61) say the current market for expanded polystyrene in the United Kingdom is about 2,200 tons a year of which nearly 1,500 tons were imported from Germany. They give a percentage breakdown of current uses as follows: cold store insulation—50; general building—30; packaging—10; transport insulation—5; marine buoyancy—2; others—3.

Expanded polystyrene is currently the cheapest rigid foamed plastic available at any density at which it is made. But it is worth noting that there are many applications where it will be unsuitable because of the relatively high transmittance of water vapour through it. In this province, at least, expanded pvc should be tried.

Microcell make an expanded pvc product under the name Plasticell and its uses fall largely under the same headings as those for expanded polystyrene. The plastics industry differentiates between the Plasticell type of product which has spherical non-interconnecting cells, and the foamed products which usually have interconnecting pores, but from a structural point of view it just means that the strength to weight ratio of the former is better and the vapour transmission is virtually nil.

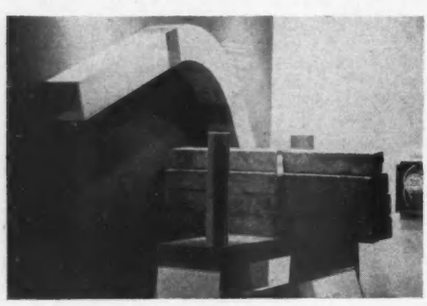
Microcell lay emphasis on the good strength of their Plasticell product and they have assembled a range of adhesives so that the product can be faced with a variety of metallic and non-metallic skins rather in the same way that honeycomb is used.

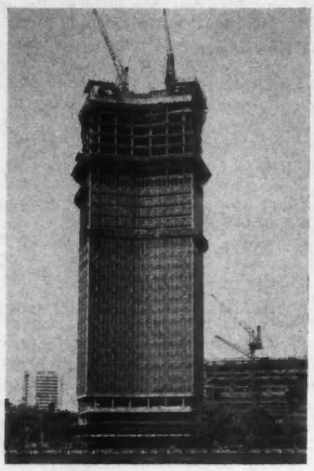
Plasticell can be made in densities from 2½ to 25 lb per cu. ft with respective compression strengths at room temperature from 40 to 1,000 lb per sq. in. Thermal conductivity is about 0·2 Btu per sq. ft per hr per ° F per in.

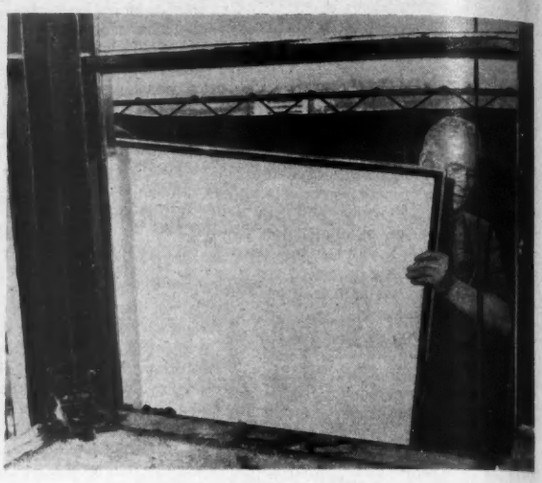
It is very easy to think up possible uses for expanded plastics, and this article is designed to show where the decision has actually been taken to put one of these materials, Plasticell, to work.

The illustration below shows the great strength of a 3 in thick sandwich panel of 2½ lb per cu. ft density Plasticell between skins of 20 swg aluminium. It is 6 ft long by 1 ft wide and is loaded with concrete blocks weighing 800 lb. Microcell say that the centre point deflection under this loading is about $\frac{3}{16}$ in and that in tests which lasted a week there was no permanent deflection. The beam would fail at between 1,600 and 2,000 lb loading, either localised or distributed.

Microcell Limited, 9 Kingsway, London WC2.







Insulation for Vickers Building

Thermal insulation panels for the Vickers Building (above) now being completed on Millbank, make use of Plasticell. One of the prefabricated insulation panels is shown being installed on site.

These panels are placed immediately behind the green glass cladding used up to window level. They consist of slabs of fine-celled Plasticell of 3 lb per cu. ft density stuck with rubber adhesive into a single dished tray of painted steel. The insulation is ⅜ in thick and will not absorb moisture even though one face is "exposed." Hills of West Bromwich made the panels in collaboration with the architects, Ronald Ward and Partners.

Recently, Microcell have been able to make their lightest (2½ lb per cu. ft) grade of Plasticell with fine cells, and in other projects for infill panels they will be recommending its use.

Air Ducts for British Railways

In the background of this exhibit at the International Refrigeration and Air Conditioning Exhibition (left) is shown an air duct. This is something like ones now being made for British Railways' Western Region rolling stock. Microcell say that for heating and partial air conditioning on this stock, BR needed to have 70 ft long air ducts made. Previously these had been made by insulating a steel box duct with an asbestos product. Although Plasticell had a price three times that of previous insulation, it was found that a considerable saving could be made on each duct because of easier fabrication. Should single or double curvature panels ever be needed, Microcell add that Plasticell in any density can be quickly heated (preferably by infra-red) and vacuum formed without collapse of the cells.

Ducts are now made for BR with double aluminium skins. The inner skin is made by wrapping aluminium sheet over a mandrel and pop riveting it together. A half inch thick layer of 3 lb per cu. ft Plasticell is then laid around it, and a thin outer casing of aluminium fixed around this. Microcell say the outer skin is only to prevent damage from stones thrown up against the duct. It should be quite possible, they add, to recommend an adhesive which would be strong even under the action of water, weather and oils and greases; Plasticell itself is said to be resistant to these, so in theory an outer skin is not needed.

Sandwich Structure for Boat

This boat has all its bulkheads and superstructure made as a large moulding in expanded pvc with glass reinforced polyester skins. The cruiser is to be used for harbour work in the tropics where it has been normal to use wood construction. Microcell say the traditional materials have a limited life in these areas due to attack by algae and marine termites and they anticipate that the new construction will give better lives.

The interior view shows the absence of beams and strengtheners. In fact, there are none, as the 1 in thick sandwich bulkheads have structural rigidity and strength equivalent to ¾ in BS marine plywood with bracing, say Microcell.

The makers, Watercroft, are using a lay-up technique developed by Microcell which gives great strength. First a skin of glass reinforced polyester is laid up on a mould. When the final layer of polyester is still wet, a "tile" of Plasticell is placed on the polyester about 3 in distance away from where it will eventually lie, and it is then run up to the edge. In this way a separator wall of polyester is formed which connects the two skins (when the second one has been applied) to form a strong box structure. The more strength that is needed, the smaller are the tiles and the greater the number of box walls.

Expanded pvc used on this cruiser was of the 4½ lb per cu. ft density which has a compressive strength of 135 lb per sq. in.

Rust Remover in Paste Form

An acid-based derusting chemical is now made in the form of a paste. The Pyrene Company are the makers and the product is called Paste Preperite.

This is described as a product for the removal of rust from iron and steel, which is suitable for spot derusting where it is unnecessary or inconvenient to immerse the complete component in a solution. After derusting it should be removed by power washing, alkali cleaning or by swabbing with a wet cloth. The paste should not be allowed to dry on the work.

Pyrene say derusting will normally be complete in 1 or 2 minutes where rust is light. It is said that parts so treated may undergo Bonderizing either before or after rinsing.

Pyrene Company Limited, Great West Road, Brentford, Middx.

Fast Welding of Massive Cast Iron

Eutectic Welding Alloys have developed a process called QuenchWeld for ac/dc arc repair welding of heavy cast iron parts. They claim that the process cuts welding time to one-tenth that normally taken.

Where previously only 10 to 20 per cent of broken cast iron parts were considered repairable, say Eutectic, this new process makes rapid and permanent repairs possible in the majority of cases.

The procedure involves rapid joint preparation with the company's ChamferTrode grooving electrodes which leave the weld area correctly V'd and including vital stress-relieving grooves. The scarfing action of this electrode leaves the joint thoroughly clean, claim the company, so that it is ready for immediate passes with a special EutecTrode which seals in any contaminants such as grease, moisture or chemical elements in the cast iron. A long arc is maintained to "wash on" a $\frac{1}{16}$ in deposit which provides a bond between base and weld metals.

The third and last stage in making a joint consists of one or more passes with a high elongation, high tensile strength EutecTrode. This is applied using back step deposition—in other words from cold to hot—with immediate quenching after each pass with a damp cloth or air-line.

The electrode coatings are said to ensure a metallurgically sound weld deposit which is low in carbon and high in grain refining alloying elements so that it is able to withstand quenching without danger of cracking.

Eutectic Welding Alloys Company Limited, Faggs Road, Feltham, Middx.

Reducing Odours Associated with Diesels

Redex have introduced a diesel oil additive which when added to diesel oil in the proportion of 1 part in 150 is claimed to avoid some of the unpleasant smells associated with diesels and the associated fuel.

In presenting this product to a meeting the other week, the director and general manager of the company said this about it and its development. "The whole question of air pollution in general and of diesel engines in particular is one which has received, and is receiving, a great deal of attention from many bodies. The National Association for Clean Air and the Royal Automobile Club have both done useful research, and recommendations have been made by these bodies which, if put into effect, will do much to reduce the unpleasant effect of diesel engines. I should also like to refer to the Diesel Exhaust Fume Abatement Society and wish them every success in their campaign to reduce diesel exhaust fumes.

"It was because of our consciousness of this problem that we were led to devote time and energy to producing a palliative, if not a complete solution, and it was with that in view that we decided after many experiments and tests to introduce Redex DD."

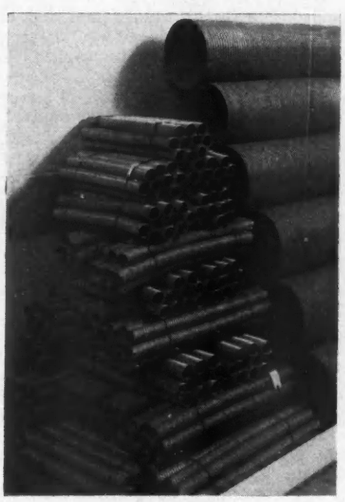
Redex DD is basically Redex to which has been added a suitable deodorising compound.

The company claim, and tests by an independent laboratory appear to confirm, that a small addition of Redex DD will do four things: (1) deodorise diesel fuel in bulk; (2) take away the unpleasant smell of diesel fuel in the driver's cab; (3) give a pleasant smell to the diesel exhaust; and (4) materially reduce, or eliminate, the lachrymal effects and nasal irritation which are so prevalent with diesel exhausts.

Redex Limited, 365 Chiswick High Road, London W4.

Steel Reinforced Pvc Ducting

Plastic ducting is now being made reinforced with steel wire in diameters between 4 and 12 in, according to Recon (Pipelines). Known as Vacuflex, this product is said to have good resistance to wear and crushing. Yet it is flexible.



Compared with most grades of rubber, pvc has the advantage of being non-flammable, but it softens quickly above about 65° C.

Recon (Pipelines) Limited, Albert Drive, Sheerwater, Woking, Surrey.

British Nylon Powder for Coating

A fine nylon powder which can be used for either dip or spray coating is now being made in Britain. Dohm Limited are making it from type 6 nylon and they say that previously the only nylon powder available to the British industry has been a type 11 which is imported from France.

The company claim that coatings may be built up with high impact strength. Corrosion resistance is said to be very high except against mineral acids and it has an electrical resistance of 600 V per mil (0.001 in). When applied by dip coating the thickness is limited to the range of 0·010 in to 0·025 in; by flame spraying the top thickness has no limit other than cost. The workable temperature range is said to be from — 40° C to 140° C.

This company have also developed a powdered polyethylene. Electrical strength is from 175 to 250 V per mil, temperature range is from — 30° C to 100° C, while coatings may be from 0·020 in to 0·070 in thick by dip coating and from 0·020 in to any economical thickness by spraying.

Dohm have been developing techniques for coating fabrics based on natural fibres with this powdered polyethylene. If desired it can be fused into a pinhole-free coating by application of heat at 120° C to 130° C but the process also lends itself to making laminates with other materials, say Dohm, when it is best to only half fuse the powder.

A range of dip coating machines, flame spraying guns and textile coating feeders is offered by the company to make use of these powders.

Dohm Limited (Plastics Division), 167 Victoria Street, London SW1.

Abrasive Wheel Based on Sponge

Finishing Aids and Tools have introduced a range of abrasive wheels made basically of sponge. This is recommended by the makers for general surface treatment and is said to produce matt or polished finishes on stainless or other types of steel, iron, brass, copper, bronze, aluminium, plastics and hard woods such as boxwood or teak. No compositions are required. It is said that precious metals can be polished with "the absolute minimum of stock removal".

Because of the structure of the sponge and type of bonding, even grain distribution and non-clogging qualities, it requires only light and infrequent dressing, say Finishing Aids. It comes in one of four grades: soft, medium hard, hard and extra hard and in a complete range of grain sizes with wheels up to 16 in diameter and 4 in thick. The maximum safe wheel speeds range from 2,000 to 6,000 surface ft per min according to grade.

Finishing Aids and Tools Limited, Chandos House, Buckingham Gate, London SW1.

Spring Alloy Has High Conductivity

A nickel-silicon-copper alloy made by Johnson Matthey and Company, called Mallory 53, is intended for electrical springs. It is said to have mechanical properties at least equal to those of the conventional phosphor bronzes and brasses.

Because of the high conductivity of the alloy. 40 to 45 per cent IACS, it is possible for springs of small section to carry appreciably larger currents than when made, say, in phosphor bronze.

All spring forming operations can be applied after heat treatment, say Johnson Matthey, and hence the alloy is supplied in the precipitation hardened condition which requires no further heat treatment by the user. A data sheet is available.

Johnson Matthey and Company Limited, 73–83 Hatton Garden, London EC1.

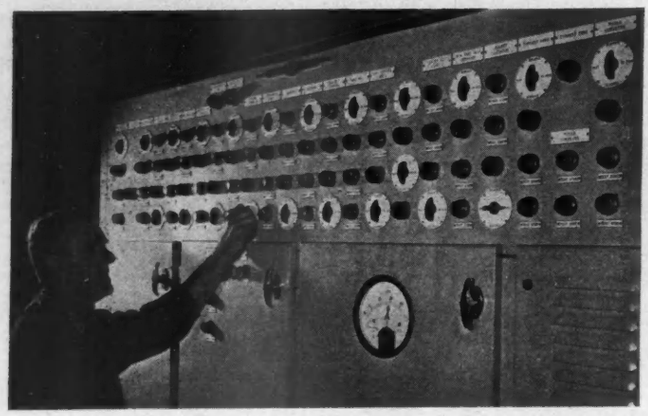


Fig. 1 The sand plant sequence control panel which governs the preparation of sand and its distribution to the moulding track.

Fig. 2 The mechanized moulding track with four pairs of machines. An operator is weighting moulds on the pallet conveyor in the foreground.

Mechanized Moulding Transforms Foundry

Mechanization of the moulding function in a Midlands iron foundry has changed its nature radically. Integrated with the rest of the foundry process, it has made possible a sixfold greater output.

WHEN extensive mechanization is introduced in a traditional industry it almost invariably demands a fundamental change in working methods and in management and operator outlook. This has been the experience of R. J. Hunt and Son, a member of the Brockhouse Group, who have recently installed in their Birmingham foundry a mechanized moulding track incorporated in a continuous-cycle casting plant. Now, moulding machines which would normally produce 300 moulds per eight-hour day turn out 2,000 in the same period.

The castings vary in weight from less than 1 lb up to 35 or 40 lb, and between 50 and 60 tons are supplied weekly to the automobile, agricultural and general engineering industries. Business on this scale would not have been possible with conventional moulding.

In essence, the overall plant layout consists of a bench level closed circuit pallet conveyor serving the coring up, box closing, weighting, casting, cooling and box knockout sections. Integrated with this closed circuit is a sand milling, preparation and distribution system which feeds the moulding track—positioned along one side of a section of the pallet conveyor—by overhead conveyor, and then recirculates unused and spillage sand to the mill by an underground belt. Ancillary conveyors also redistribute weights and empty boxes to the appropriate points in the main system.

It is the sand treatment and supply system governed by the sequence control panel in Fig. 1, which is the key operation. The sand mixer is a Foundry Equipment Limited 30 tons per hour mill sequenced to add binder and coal dust to the unit sand in the necessary proportions through a vane type dispenser. New sand is also added, as required, together with water.

Milled sand is conveyed via an elevator and aerator to a distribution belt running above the line of moulding machine storage hoppers. The hoppers, each serving one machine, are charged by a system of automatic sand ploughs, actuated pneumatically and controlled by high and low level electronic probes.

Unused sand then recirculates under the moulding track where it is joined by overspilled sand which has fallen through the completely gridded floor. This sand then joins—and has a desirable cooling effect on—sand conveyed from the mechanical knockout. After passing under a magnetic separator, used and unused sands are then elevated together into a rotary screen and thence into a 150 ton capacity storage hopper. As a safety precaution, the elevator and rotary screen have a maximum capacity of approximately 60 tons per hour, compared with the mill capacity of 30 tons per hour, to guard against the possibility of knockout sand and return spillage sand combining at any one time to overload the system. This might conceivably happen, for example, if a moulding machine hopper were opened at the wrong time and a cascade of overspill sand virtually short-circuited the recirculation system.

From the storage hopper to the mill, the sand is then carried by two slow-moving, fully supporting, 36 in wide conveyor belts which are fitted with restraining gates to adjust and control the feed. The cycle then recommences.

Once it has been programmed on the control panel, the cycle is started by a single push button. Warning of any failure is given by prominently placed lights and, in that event, all earlier stages in the preset sequence of operations are automatically stopped. Where maintenance work is necessary, the sequence can be broken by the use of by-pass and test positions.

The moulding machine line, shown in Fig. 2, consists of three pairs of British Moulding Machine BQI automatic machines and one pair of Foundry Equipment magnetic moulding machines, each machine having a potential output of 100 to 120 mould parts per hour. Mechanization has made high utilization of these machines possible, and it has also converted the moulder from a man with a strong back and years of craft experience to a machine operator extracting the best possible value from his expensive equipment with a minimum of physical effort.

MELTING MODIFICATIONS

When the mould parts have been made, they are placed on the constantly moving pallet conveyor—together, incidentally, with coloured tokens from which bonus rates are calculated—and automatically transferred to the weighting and casting area.

After weighting of the moulds, casting is from one of three 5 cwt capacity ladles suspended from a mono-rail system which is linked with the cupola hot metal receivers. A major ancillary problem in introducing the mechanised moulding plant was the necessity for improving the melting plant to ensure an efficient supply of iron.

There was insufficient time to install a new section—the actual work on it had to be carried out during the 14 day August shut-down last year—but the existing four cupolas were successfully adapted in the following ways.

(*a*) The entire cupola base plate was lifted 4 ft to suit 2 ton hot metal receivers;

(*b*) General combustion was improved and stack temperatures lowered by inserting a 5 ft 6 in section below the charging hole;

(*c*) Stack height above the charge hole was increased to protect the wet arresters against excessive heat;

(*d*) Whiting type water wash grit arresters were installed;

(*e*) Larger fans were fitted to overcome stack resistance resulting from the increased charges;

and (*f*) Cupola practice was improved by the installation of a central control panel, incorporating blast volume recorders, and interlocked fan and arrester pump starters.

Fig. 3 An operator working the mechanical mould knockout. The pallet conveyor is on his left and, above it, is a conveyor for empty boxes.

Returning to the casting process, the cast moulds remain on the pallet conveyor and pass through a fume and cooling tunnel before arriving at two mechanical knockout positions. Here, dust and fume extraction—together with that from the inclined belt, mill and rotary screen in the sand preparation system—is by ducting to a wet type arrester sited outside the foundry.

Thus, a corollary of mechanized moulding has been improvements in technique and handling at most other points in the casting system. Indeed, this new production line bears little relation to work still carried out for certain castings on an adjacent manually operated line. Operators used to the old method of working have had to unlearn their old skills before learning the new ones. As far as this mechanized track is concerned, all labour is green labour.

R. J. Hunt & Son Limited, Lifford Foundry, King's Norton, Birmingham 30.

Electronically Controlled Drilling

An electronically controlled multi-spindle drilling machine is said to have paid for itself by savings in tooling costs on its first job in GEC's telephone works in Coventry. Its rate of work has also been such that the girl operator can turn out drilled components four times as quickly as with conventional drilling.

For future jobs the only further equipment necessary will be new control tapes, and it will be a comparatively simple matter to incorporate any design modifications. Set-up times are also vastly different since a new tape can be fitted in fifteen minutes compared with approximately ten hours for altering a jig.

The problem for which this machine was introduced was the drilling of varying numbers of holes in small batches of differently designed printed circuit boards. An EMI-Grimston positioning table was fitted to a seven spindle drilling machine, which was also controlled by the EMI system and was specially designed by GEC's own technical services department. The positioning equipment uses a measuring element with an electrical accuracy of $\pm 0{\cdot}0005$ in, giving a guaranteed positional accuracy of the table of $\pm 0{\cdot}002$ in with repeatability to $\pm 0{\cdot}001$ in. Information can be fed into the system by punched tape or set up on dials.

The operator loads a removable baseboard with seven packs, each of five printed circuit boards located by datum holes on pins and then fixed to the table. The x ordinate is read and the table moves in the x direction and is locked. This procedure is then repeated for the y ordinate; the spindle feed is actuated and drilling takes place. Reading of the x ordinate for the second cycle begins while the spindles are retracting, and duplicate baseboards facilitate unloading and reloading of one while the other is in use.

As is usually the case with automatic control of machine tools, the advantage of this system lies not only in increased operating speed but, more important perhaps, in its guarantee of absolute accuracy. Under manual control, the most diligent operator can accidentally overlook drilling one or more holes. Such an oversight would remain unnoticed until final inspection, causing considerable delay while the printed circuit boards return to the machine room.

Starting the machine after loading a baseboard.

EMI Electronics Limited, Hayes, Middlesex.

The Versatile Conveyor—Friend or Foe?

The production or methods engineer who regards conveyors as the panacea for all flow production ills is asking for trouble. Once a conveyor has been installed—except perhaps for the more simple and portable roller types—a department is married to it and the shop layout can lose flexibility. Indeed, some of the most dramatically complex conveyor systems have become embarrassingly inefficient with changes, sometimes only slight changes, in company manufacturing policy or in market requirements.

Used wisely and with careful planning, however, conveyors can repay their capital cost very quickly by savings in handling costs and by getting components to the right place in a production line at the right time. On this latter point the critics of conveyorisation often neglect the value of keeping operators and machines fully utilised instead of losing potential production time in waiting for parts or in self-service.

The use of conveyors is common to all types of industry, so that ideas developed in one manufacturing process can often have a useful application in quite unrelated industries. This wide use of conveyors also enables conveyor manufacturers to standardise their products with consequent reductions in cost.

Two recent applications of conveyor systems which might contain the germ of ideas for other firms are in the assembly and packing departments of Sanderson Fabrics and in the plating shop of the Wilmot Breeden car bumper works.

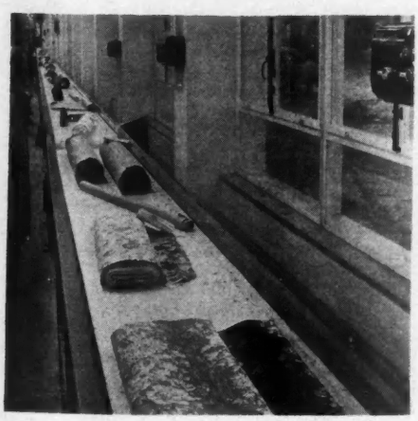


Fig. 1 Part of the 340 ft belt conveyor at the Sanderson Fabrics factory.

At Sanderson Fabrics' Uxbridge works, assemblers used to draw material from storage racks. Now a Sovex conveyor installation distributes a smooth flow of work to the operators, who no longer have to waste time acting as part time service operators. Work is carried to them on a belt 2 ft wide by 340 ft long (Fig. 1) of solid woven cotton covered with Pvc.

An interesting feature of this belt is that the last 60 ft is, in fact, a separate belt running at a speed of 20 ft per minute, while the first 280 ft runs at 60 ft per minute. This difference in speed has been arranged to allow for the variations in operating times from operation to operation. An arrangement of this kind gets round the objection, sometimes made, that conveyors tie operators to a set operating speed. Often, of course, this objection can be met by a redistribution of manning but, where this is not possible, conveyors can provide varied feed speeds.

After the checking operation, this Sovex system changes to an overhead conveyor chain which carries orders to the packing area on dustproof aluminium trays. Such overhead conveyors tend to be more expensive and more inflexible than floor level conveyors but their operating cost is lower for longer distances—i.e. travel between departments, rather than between operators—because they do not take up valuable floor space or impede other production lines.

On this particular conveyor, provision is made for even distribution to the discharge chutes serving the different packing stations by five triggers on each tray. These triggers are mechanically set in turn as the trays approach the chutes, and are tripped so that the first tray discharges into the first chute, the second into the second chute, and so on. If a chute becomes full, a light ray stops the discharge mechanism.

Once packed and sealed, the fabrics return to another 2 ft wide belt conveyor running the whole length of the packing department at bench height at 60 ft per minute. A steeply inclined belt, fitted with a special rubber grip surface, then takes them to the dispatch glacis.

The second system, a Wilmot Breeden car bumper installation, has been introduced at their Amington Road, Birmingham, works by British Monorail. This consists of a semi-automatic overhead conveyor and hoist system on which the bumpers, loaded on jigs in batches of up to twenty, pass through all the plating stages in a continuous cycle without being removed from the conveyor.

Speedy and smooth raising, lowering and transferring of jigs is ensured by a full circuit with separate out and return lines of overhead dual runways 152 ft long, parallel with each other and connected at each end by a transfer crane section. The weights involved are of a greater order than those supported by the Sanderson system, and independent powered hoist carriers, with one ton hoists attached, are suspended between the rails of each runway. Pendant controls on each hoist carrier control the raising and lowering of the hoist and the motion of its carriers along the runways, as in Fig. 2.

Movement of the material along the conveyor is by an electric motor which drives a rubber-tyred wheel in contact with the underside of both runway rails. Along the plating line, speed of travel is 100 ft per minute, the highest speed which will allow the operators close control over the jig positions, but on the return line, where there are no intricate movements, speed is increased to 200 ft per minute.

These conveyor applications, by Sovex and by British Monorail, demonstrate how two rather sophisticated conveyor systems have been put to good use. Sometimes a less highly developed scheme, such as a few standard lengths of gravity feed roller or wheel conveyor, is sufficient to streamline a smaller application. Always, though, a production engineer should make quite certain that he is introducing the conveyor system that is best suited to his requirements, and the best way of doing this, once he has an idea of his bare requirements, is to take expert advice.

Sovex Limited, Erith, Kent.

British Monorail Limited, Wakefield Road, Brighouse, Yorkshire.

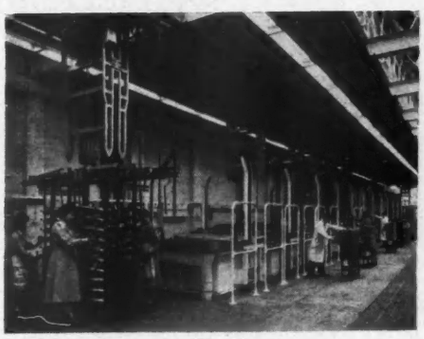


Fig. 2 The overhead system in the plating shop of Wilmot Breeden's car bumper works.

On the Shelf

By Frank H. Smith

ONE day I am going to write an article on the books and material I have collected on Librarymanship but have never read. I've lashings of the things and I am always swearing that I will force myself to read them and become a better and more confused librarian. (The same thing happened when I went to dancing classes: I got so bemused with theory I went completely off the beat). My latest acquisition is *Research Engineer* for April from the Georgia Tech. Engineering Experiment Station, Atlanta, Georgia. It is devoted to the information problem and I only wish I had the space to expand a little on it. But I will quote from "The President's Page": "In the foreseeable future, other countries may rise up and equal or surpass the technology and consequently the standard of living of both the United States and Russia. This driving force that permits whole countries to progress in leaps and bounds over a relatively short period of time is simply utilization of *accumulated technical information*" (his italics). You may wonder how I get these outlandish pieces of information. If I told you, you'd be as good as I am, so you just stick to the books that tell you how to go about it and you'll be all right.

Having heard much of tabloid newspapers, the title *Capsule News* is likely to cause a "double take." It is a (four-page) news-sheet from R. P. Scherer Limited, Slough, Buckinghamshire, who, believe it or not, make capsules. Those who think that encapsulated products (lovely term) are confined to halibut liver oil should get this house organ and learn, for instance, that you can get smoke for model railway engines in capsule form, also perfume for artificial flowers, conditioning for racing pigeons, diesel engine "starters" for cold weather, and so on.

Pergamon (Headington Hill Hall, Oxford) send yet another specialist journal, *Infrared Physics* (infra penny infra pound) at £7 per annum for the bodies and £3 10*s* for individuals. My readers will know by now of the Pergamon rate system whereby libraries, research institutions and what-have-you pay twice as much as the oath-taking individual. A casual look (and anything more would frighten me) fails to reveal how often this comes out.

The British Iron and Steel Federation has produced a 142-page English/Russian and Russian/English glossary of commercial expressions to help cope with all these to-and-from exhibitions and trade fairs between London and Moscow. You can get single copies for the asking from Steel House, Tothill Street, London SW1, and bulk orders will cost money *but it will do you no good at all unless you can read Russian.*

Having read all about how hard-up school teachers are (and the *Daily Telegraph*, I see, says that librarians are even harder up—hard-upper) it is difficult to understand where the market is for *Technical Education Abstracts from British Sources, September-December, 1960*, but there they are—Volume 1, No. 1, April, 1961. The publishers are the National Foundation for Educational Research in England and Wales, at 79 Wimpole Street, London W1, and the price £2 2*s* per volume of four quarterly issues. The abstracts are positively and lengthily informative (200 words) and cover over 150 sources (including, of course, Old Faithful). It is pleasant to see that the assistance of over 100 abstractors is acknowledged. In many libraries and private bookshelves these abstracts could well fill the famous long felt want.

Any firm that had nothing in the "Canberra" must feel a bit out of it, but it seems there was enough nickel in her to justify a booklet *Nickel in S.S. Canberra*, on the owt for nowt basis from the International Nickel Company (Mond) Limited, Thames House South, Millbank, London SW1.

Wears a Hole in the Pocket

Whitaker's Almanack, 1961. 93rd Edition. *J. Whitaker and Sons Limited.* (*Cloth edition* 21*s*)

Henschel Lokomotiv-Taschenbuch, 1960. *Henschel-Werke GmbH, Kassel.* (16·80 *DM*)

Taschenbuch für Wehrfragen, 1960/61. 4th Edition. Compiled by HANS EDGAR JAHN, KURT NEHER and HERBERT PFEILL. *Verlag Soldat und Technik im Umschau Verlag, Stuttgarter Strasse 20-24, Frankfurt a.M.* (14 *DM*)

By definition, reference books are almost unreviewable, since they must be lived with and used constantly in order to discover their strengths and their weaknesses. However, here are three more; and what a nuisance it is that publishers of reference books cannot agree among themselves that they should all be the same shape, and that the indexes should all appear in the same places.

To review an institution such as Whitaker is emotionally very difficult; it belongs to those boyhood memories of a treasured mine of information which appeared once a year, bound in soft leather and printed on high class paper, the present of a well known transformer manufacturer. Its use unfortunately demonstrates that it also has a certain unwillingness to move with the times. Nobody reading the section entitled "Science, Discovery and Invention in 1960" would get any impression whatsoever of what had been the major trends of development in science and engineering during that period, although he would gather some delightful and odd bits of information which probably would have escaped his normal reading.

On another page, the Institution of Electrical Engineers only manages to achieve four lines because of the decorations of its distinguished president, while the Distressed Gentlefolks Aid Association requires three. The 16 pages of rather bad illustrations might well be sacrificed to providing more facts relevant to a society which cannot live, much as parts of it might like to do, without industry.

To boys of all ages with a taste for locomotives and a smattering of German, Henschel's handbook on locomotives will arouse emotions oscillating between pure and unadulterated joy at such riches, and fury that the steam locomotive has been relegated to the end, while pride of place is given to diesel, electric and even gas-turbine locomotives. This book is a mine of information, and is not strictly confined to what Henschel have done, much though that is.

For those who need to know about the German armed forces today, the pocket book on German defence problems is probably a must. For those of us who once had to, it is nice to discover how out of date our once hard won knowledge has become; and to discover that a *Kapitän-leutnant* now wears only two stripes of gold braid round his sleeve, while a *Korvetten-Kapitän* has two and a half, thus righting what used to be an annoying social anomaly when the British and German Navies met.

D. B. WELBOURN

New Look at New Delhi

Indian Economic Policy and Development. By P. T. BAUER. *Allen and Unwin.* (16*s*)

Professor Bauer has written a disturbing report on the methods of India's planners and a damaging indictment of their objectives, which, if New Delhi wishes to continue to attract foreign aid, it should ponder with the utmost seriousness.

The professor castigates the misconception, widespread in developing countries, that all investment expenditure, other than on current consumption or government services, can be regarded as "investment" productive of income. This encourages (1) "investment" regardless of cost in terms of alternative uses of resources, and, (2) a wide range of controls in the belief that they are necessary to ensure a particular level of investment expenditure. Such controls are likely to hinder the economic allocation of resources and their growth.

This obsession with investment expenditure causes other factors to be neglected which promote development, such as measures designed to spread an exchange economy in place of a barter and subsistence economy, to spread education, primary and technical, to break down social customs, such as caste, which wastes talent by preventing millions from pursuing more productive work than that in which they are engaged. Caste restricts occupational mobility and slows the spread of new ideas and methods; it enforces an uneconomic division of labour and unnecessary duplication of equipment, including even simple tools. The disabilities of the depressed classes, estimated at 70,000,000, or about 17·5 per cent of the total population, constitute a drag on the whole economy. The government is admittedly trying to relax the hold of caste by propaganda, but its effort is "very limited."

Simultaneously with the modern ideas expressed in planning, new legislation has prohibited cattle slaughter. Besides decreasing India's already scanty food supply, the attitude promoted by these new laws obstructs progress in agriculture and, notably, decreases the milk supply by preserving worthless cattle. The net result is that India's cattle do not support the people but are supported by the people.

The professor lists many other retrogressive social customs, such as the joint family system, which obliges even modestly well off people to share their income with even distant relatives. He shows that Indians are just as capable of energy and enterprise as any people in the world, as is proved by the outstanding commercial and industrial success of many millions who have emigrated to countries where industry, thrift, and the ability to exploit economic opportunity, are not frustrated by an archaic social structure.

Professor Bauer plausibly argues, with the aid of facts and figures, that India's Five Year Plans, far from promoting material progress, widening social horizons, and opening up ever more opportunities for the individual to exploit, are actually consolidating the forces of inertia. He condemns the planners' doctrinaire preoccupation with investment in physical plant and their failure to invest in human capital by education.

He observes that the Government's efforts to repress inflation and to secure for itself the resources required for its spectacular Plans, lead it to control private enterprise more closely than in almost any other country outside the Iron Curtain. The Government controls capital issues, allocation of raw materials, imports, exports, and foreign exchange transactions with all countries, even those of the sterling area. The Government has taken power to licence the setting up, extension, change of location, or even the production of a new article, of all substantial enterprises. It can prescribe prices, methods, the volume of production, and the channels of distribution, can prohibit an enterprise from reducing its output or its capacity, can remove directors and executives and replace them by its own appointees, without right of compensation.

Indians assure foreign observers that these rights are only meant to be used against rascals, not honest men. It nevertheless remains true that these rights exist and could be used to stifle any enterprise to which some government official took a dislike, and it is important to ask whether the existence of such legislation is not in itself more dangerous to the economy by creating apprehension, and by inhibiting initia-

tive, than the evils that it is supposed to check.

Professor Bauer stresses that such powers of life and death over private enterprise are not necessary for the extension of the public sector. If unnecessary, why are they there? Their effect is often to increase the profits of existing enterprises by shielding them from competition by new entrants, and they have created controlled sellers' markets. They have strengthened previously existing private market-sharing schemes —or have made them unnecessary! The operation of controls has, on occasion, secured large windfall profits to the recipients of controlled supplies as the market prices of these resources were often far higher than those to which they were allocated. Thus controls have often been welcomed by existing firms.

However, these controls are mixed blessings, because along with the rest of the economy, firms which benefit by them in any way suffer by the general retardation of economic progress. Moreover, the close official supervision of all their activities, including production methods, raw materials purchase, and output disposal, spreads the idea that private firms are functionless, and this makes political demands for their expropriation more plausible. India's controls are especially hard on medium and small size enterprises. Many of these are efficient low-cost producers or distributors, but their managers do not understand the law's intricacies, cannot afford prolonged disputes, and are easily overawed by authority.

Professor Bauer demonstrates that major elements of India's planning are, paradoxically, inconsistent with any hope of improving the living standards of the masses. Nor was the Second Plan's unplanned inflation a model of successful planning. It is characteristic of unsuccessful planners that they call for bigger and bolder plans and for wider and more ruthless powers. "There need be no limit to this process," comments the professor, "since success or failure of planning, and economic advance or stagnation, can all be adduced as arguments for more ambitious planning." The paradoxes of India's planning are largely explained by its first two officially proclaimed objectives, which are "To attain a rapid growth of the national economy *by increasing the scope and importance of the public sector* and in this way *to advance to a Socialist pattern of society*; and to develop basic industries for the manufacture of *producer* goods to strengthen the foundation of *economic independence*" (reviewer's italics). These objectives attach no value to consumers' choices, or to individual liberty, and suggest the monolithic Soviet type of Socialism. This impression is strengthened by a memorandum prepared for the Second Plan, in which one of India's most influential economists said: "... What I do suggest is the need for a thorough review of the Constitution, with a view to seeing that it facilitates rather than hinders recourse to planned economy and a Socialist pattern of society."

It is often argued that if the free West will not aid India, she will be absorbed into the Soviet sphere. But, unless Professor Bauer is refuted, this argument may henceforth cease to cause so much alarm and despondency if it becomes clear that the Indian Government's aim is to turn India into a People' Democracy. If India is to be lost to the free world in any case, the West may well be led to ask itself why its hard-earned savings should be used to promote a rush job.

JOSSLEYN HENNESSY

Choosing and Controlling the Decision Makers

The Cost of Freedom. By HENRY C. WALLICH. *Harper and Brothers, New York; Hamish Hamilton, 90 Great Russell Street, London, WC1.* (25*s*)

Science and Government. By C. P. SNOW. *Oxford University Press.* (9*s* 6*d*)

How far is making a choice between alternatives on a national scale a political act or a technical decision? In all ages most would probably agree that choosing lines of action in matters of public policy consists of each of these elements. A century ago the issue was argued mainly in terms of rights and obligations. In forming their political attitudes and placing them in historical perspective, men tended to emphasise the part played by the State. Its capacity for personal and impersonal tyranny repelled the Nineteenth Century liberal thinkers; it fascinated the Hegelians. The price of liberty, according to the philosophical radicals, was eternal vigilance.

The subtitle of Professor Wallich's book is "A New Look at Capitalism." It is an essay in modern, humane, enlightened conservatism. It is urbane, readable and essentially reasonable and civilized in its approach. Edmund Burke would have understood it well and in consequence it is something of a misnomer to call it "a new look" at anything. It is a persuasive rethinking of old but vital issues on old familiar lines.

The Professor (the book comes from the United States) looks back with approval at the Founding Fathers, the Frontier and all that made Nineteenth Century America grow fast. Like Burke he has a disposition to preserve and an ability to improve. But he faces the challenge of Communism squarely. He has some simple but sound things to say about economic growth. In the end he wants freedom above all else for the individual and thinks we should be ready to accept in full awareness that there is a price to be paid when we try to maximize our standard of living, and be prepared to pay it.

C. P. Snow's slender but valuable book is concerned with a different kind of juggernaut. This time it is not the State but technology. At first sight the two books appear to have little in common except that they were prepared initially for an American audience (C P. Snow's book is in fact a series of lectures given at Harvard College.) They are in the end uniquely related.

He is concerned to plead the need for more scientists in high places of government, considering that they are more forward-looking than politicians and professional administrators, more aware of "knowledge to come" to use his own phrase. But he has reservations about including engineers in this category.

He has these reservations because he thinks that although engineers are technically bold they, as a profession, tend to accept their social environment at least for thinking purposes. His preoccupation with this theme is because of the vital need to choose rightly to get maximum technical progress from a mass of alternative and conflicting data. Only if we choose well, with an eye to the future of need and knowledge (his point about appreciation of knowledge to come) can the Western way of life justify itself and survive.

His case history might have been rocket fuels in a current context. The one he chooses, and handles well and with a fine partisan flourish, is the quarrel between Tizard and Lindemann in the last war. The hero of this part of the book is Tizard; but the conflict is incidental to the main theme: that in war a group of highly trained scientific minds is a safer recipe for sound decisions than the tyranny and gadget-mindedness of the single omnipotent scientific adviser.

In peacetime, in times of rapid technical change, the choice of the right technical approach on major scientific developments is as complex and as fraught with peril if a wrong turning is taken as in wartime. The author wants able scientists in government to take the right long-term view, while administrators grasp at the short-term solution. He discounts the political influence on these issues, for clashes of opinion in a highly rarified scientific atmosphere do not get through to the electorate. However, the consequences of those decisions may eventually strike the public in a most forceful way.

He would not go so far as to say that we need a scientific elite to govern us. If he did another "new despotism" would be on the threhold. How are we to get the right kind of scientists to make their maximum contribution on the lines the author would want? C. P. Snow does not say so, but surely the answer is by creating an atmosphere of intellectual freedom for everyone including the scientists? Professor Wallich would say that in the end free men take more right decisions than the other kind. If that is so, highly complex technical decisions are best taken in an atmosphere of intellectual, hence political, freedom.

G. E. TEWSON

Can Units Reconcile Phenomena?

Electrical Theory on the Giorgi System. By P. CORNELIUS. *Cleaver-Hume Press.* (32*s*)

Have you a baby at home and do you sometimes give it its bottle? Do you experience difficulties during the process of transferring the milk from the bottle to the baby and have you ever wondered whether the problem is one of fluid mechanics or applied psychology? The answer is much easier than you can have imagined and it would be selfish of me to keep it from you.

Notice then that the management of babies is essentially a problem of units. Your difficulties stem, without the slightest shadow of doubt, from the fact that you have bought the baby food in old fashioned 12 oz tins. Change your supplier and buy the stuff in kilogrammes, you will enjoy unbroken nights, baby will thrive and your difficulties will be at an end.

Does your wife make her own dresses and do they occasionally fail to please her? Is she thinking of taking a course in dressmaking in order to become more proficient? Tell her that she need not trouble to do so. If only she will buy the dress material in metres instead of yards, all her dresses will fit perfectly.

Are you in your professional work sometimes baffled by the behaviour of electrical devices? Would you like to understand the behaviour of transformers or transistors or transductors, of amplidynes or parametric amplifiers? Do you mistakenly imagine that the mental effort required would be considerable and would consume more time and energy than you can spare? The secret of success in this as in other fields is entirely a matter of units. Use the MKS or Giorgi system and the thing is as good as done.

Did you say you do not believe it? Well, come to think of it, no more do I. You say, you have used MKS units for years and it has made no difference How very curious, that is exactly my experience, but you see I am reviewing a book and I have been passing on to you its message.

Use the MKS system, says the author, and if

one wonders how a change of units can possibly help one to understand the nature of electricity then the author replies: " It is wrong to regard systems of measurement only as systems of units. The systems of measurement are equally and even primarily a systematic combination of equations and definitions, which form an organic whole with the corresponding units. Hence the choice of a suitable system of measurement has a much greater significance in the correlation of phenomena and the formulation of theoretical concepts than can emerge from the standards of length, resistance and so forth."

To the author the MKS system is thus a *Weltanschauung*, a philosophic system rather than a system of labels by which the magnitude of physical quantities may conveniently be compared. Moreover, it is to him a philosophic system which is essentially superior to other systems, because it lays bare the very nature of electrical processes.

Two questions at once arise in the reader's mind. Is the author's philosophy inherent in the MKS system or in the author's mind, and secondly does this philosophy actually lead to a better understanding of electricity? The second question is by far the more important one to engineers whose work is continually calling them to deal with new processes and devices. We are all learners, especially those of us who teach.

The author's thesis is that electrical phenomena are nothing to do with mechanics. Although he is content that mass should be defined in terms of gravitational interactions, he thinks it a mistake to define electric charge in terms of its law of interaction. Instead he proceeds to use Ohm's law as his fundamental statement. Thus on page 1 he writes:

" For conductors (metals, carbon), Ohm's law applies

$$I = G V$$

where I = current in amperes,
V = potential difference in volts,
G = conductance in A/V (ohm.)"

But what this current is, and what is meant by potential difference, and whether G is anything more than the ratio of I/V we are not told.

Later he states that the current is a current of electrons and these possess " charge," but there is no definition of this quantity. Conductance is defined as a measure of internal friction, but potential difference remains a shadowy concept throughout the book. In fact the word " difference " soon disappears and one reads of potentials being applied to capacitors and to transmission lines. The impression given by the author in all this is that there are two phenomena in electricity, current and voltage, and that while current is related to charge, voltage apparently is not.

After Ohm's law the author deals with capacitance and inductance. In discussing the former he mentions somewhat disapprovingly the concept of electric field. Apparently there is no electric field in conductors, or if there is then the field in capacitors is a different sort of field. Inductance is defined in terms of potential pulses.

It seems that electromotive force is the same as potential difference—in spite of the fact that potential difference has been shown to be a scalar quantity. This reasoning leads to considerable confusion in the discussion of the behaviour of radio aerials later in the book. The author takes the wise precaution of limiting his discussion to aerials which are small compared with a wavelength, even so he is in trouble with two types of electric field and has to take refuge in such terms as loop effect and capacitive effect.

One of the author's articles of faith is that E and D are not the same thing, neither are H and B. He strongly disagrees with Becker, whom he quotes to the effect that " the electromagnetic conditions existing at a point in a vacuum can be fully described in terms of an electric vector E and a magnetic vector B (or H)." The author strives to disprove this and as the result of his labours the reader is left not with a phenomenon called electromagnetism, but with a whole set of apparently unconnected phenomena all occurring at the same time and in the same place.

Does this method lead to a better understanding of electricity? The answer must inevitably be coloured by one's own experience. The author's method might well be appropriate to those whose minds are like card-index systems. Thomas Edison, the inventor, was such a man who could store vast numbers of isolated facts in his mind and pull them out at will. He even did without Ohm's law, saying that such knowledge would interfere with his experiments. But such men are few.

Most of us remember things by their relationships and much of the progress in electrical engineering is due to the tightly linked chain of reasoning which holds the different experimental results together and enables engineers to predict the behaviour of complicated devices. The keystone of electromagnetism is the idea of electric charge and the rest of the phenomena are described in terms of the statics, kinetics and dynamics of charge. In turning his back on the concept of electric charge and in refusing to have any truck with " old-fashioned " mechanics, the author has gone far towards pulling down the whole house about his ears, the bricks are still there but a pile of bricks is not so useful as a house.

We come then to the other question: is the author's philosophy inherent in the MKS system? Surely not, for when all is said and done a system of units is just a system of units. They may be convenient or inconvenient but they cannot be right or wrong, true or false. The MKS system is tolerably convenient for many purposes, like the English language which is a good medium of communication, especially if one is brought up in it. It is awkward that foreigners do not always speak English, but they can be forgiven, as also can engineers who measure magnetic flux density in lines per square inch.

But to change the units in order to understand the nature of things without having to work so hard, alas, alas, it cannot be done. The dresses will fit no better, the baby will cry as loud as ever. That's the sort of world it is.

P. HAMMOND

Supercritical Data

VDI-Wasserdampftafeln mit einen Mollier (i,s)-Diagramm bis 800° C. 5th Edition. By ERNST SCHMIDT. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (15 *DM*)

The fifth edition of the VDI Steam Tables edited by Professor E. Schmidt for the Verein Deutscher Ingenieure replaces the edition published at the time of the Fifth Steam Tables Conference held in London in 1956. Essentially it differs only from the fourth edition in extending the tables for superheated steam from 300 to 500 atmospheres, while keeping to 800° C as the upper limit of temperature.

Above 600° C the extension to the higher pressure was based on the previously used equation of state, while below that temperature use was made of the edition of Vukalovich's Steam Tables published in the Soviet Union in 1958 and of the Interim Steam Table published by the American Society of Mechanical Engineers in 1956. The Russian tables extended to 1,000 atmospheres and 1,000° C, while the interim American tables, which were not based on any new experimental data, extended to about 700 atmospheres and 870° C.

The new edition of the tables under review consequently does not add anything definitive to the knowledge of the properties of steam at elevated pressures and temperatures. Such addition must come from new experimental data, and must await the result of the considerable amount of experimental work at present being carried out, principally in Great Britain, the United States, the USSR, and Western Germany. Much of this work is at an advanced stage, and it has been the policy of the British participants to await its outcome before proceeding to the preparation of new steam tables, a task which is already under review and which should reach its culmination within the next two years.

In the meantime the British worker who is interested in the properties of steam at elevated pressures and temperatures will fall back gratefully on the work of Professor Schmidt and of the others who have faced up to the task of extrapolating into a region in which there is at present an insufficiency of exact experimental data.

R. W. HAYWOOD

New Books

Sur les Distorsions des Corps élastiques (Théorie et Applications). By VITO VOLTERRA and ENRICO VOLTERRA. Mémorial des Sciences Mathématiques, fasc. 147. *Gauthier-Villars, Quai des Grands-Augustins 55, Paris.* (24 *NFr*)

Vito Volterra's classical treatment of the equilibrium and deformation of elastic solids has been revised and brought up-to-date, with reference to its applications in solid-state physics, rheology, geophysics and structural engineering. Almost a quarter of the monograph is devoted to the design of structures.

Who's Who in the Motor Industry, 1961. *Temple Press.* (42*s*)

A comprehensive directory of the British motor industry and its personnel, including professional, commercial and sporting organizations.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Hot Dip Galvanizing. HOT DIP GALVANIZERS ASSOCIATION, 34 Berkeley Square, London W1. Introduction to suitability of hot dip galvanizing as protection for fittings for buildings. 10 pp. ill.

Water Bar. EXPANDITE LTD., Chase Road, London NW10. New corrugated fibre water bar is used for lift joints in concrete where there is no movement. 1 p. ill.

Terylene in Industry. IMPERIAL CHEMICAL INDUSTRIES LTD., Fibre Division, Harrogate. Properties and brief review of industrial polyester fibres. 32 pp. ill.

The Reviewers

Mr. D. B. Welbourn, M.A., M.I.Mech.E., M.I.E.E., is director of studies in engineering and a fellow of Selwyn College, Cambridge.

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Mr. G. E. Tewson is a partner in the firm O. W. Roskill, Industrial Consultants, having graduated in economics at Glasgow University and served as the editor of a business journal.

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Marketing

Modernization and Meter Export Enthusiasm

THE modernisation and reorganization programme FERRANTI are carrying out at a cost of £200,000 in their electricity meter department at Hollinwood, Lancashire, is expected to increase production by about 30 per cent and to be completed by the end of the year.

Phase One is the reorganization of the meter plating shop. This is already being carried out. Phase Two, which has also begun, includes the installation of a wide range of new equipment and the improvement of plant layout in other sections of the department.

The third and final phase will be completed with the introduction of a new 33 station automatic in-line linked transfer platen machine, made by JAMES ARCHDALE & Company, of Worcester, costing £84,000. In the new transfer line, once the meter frame has been clamped in the platen fixture, it will be passed through the complete sequence of machining operations without removal from the jigs, thus giving improved machining accuracy.

The manager of the department, Mr. J. Prince, who is also a Ferranti director, has said that impetus has been given to the modernisation plans by the highly competitive conditions now obtaining in the meter field. Maximum production facilities are being increased in order to be in a strong position to handle more business in short time delivery circumstances.

Ferranti are the largest UK exporters of meters, holding about 50 per cent of the overseas market. It is hoped that one effect of the modernization scheme will be the intensification of the export sales drive.

New Hire Company for Contractors' Plant

The companies hiring out contractors' plant have been joined by a new concern, R AND M PLANT Limited, whose headquarters are at Wealdstone, Middlesex. The new company is to arrange long term, or contract, hire of large and specialist types of heavy equipment including drilling rigs, as well as the full range of plant, taking in mobile cranes, compressors, dumpers, mixers, road making and all types of earth-moving plant.

R and M Plant will cover all England, dealing in machinery employed by the nationalized industries, local authorities and Government departments, and mechanical handling equipment, in addition to the hire or purchase requirements of the civil engineering and building industries.

Director for New Paint Organization

The PAINT MANUFACTURERS' JOINT EXECUTIVE COUNCIL is the body recently created by the NATIONAL PAINT FEDERATION and the SOCIETY OF BRITISH PAINT MANUFACTURERS for negotiations on the external affairs of the paint producing industry. The executive council has now been strengthened by the appointment of a director, providing a spokesman for the industry and making easier the representation of the paint manufacturers' views to such bodies as Government departments, the British Standards Institution and the Federation of British Industries.

The UK paint industry is now represented on the European Committee of the Paint and Printing Ink Manufacturers' Associations. The first meeting of the Association at which the British interests were able to attend was held in Paris on 24 and 25 April.

Committee for Figures

A statistical committee, whose findings will be issued on appropriate occasions, has been set up by the executive council.

First director of the joint council is Mr. Keith S. Flory, whose career has included posts with TOOTAL BROADHURST LEE, of Manchester, SMITH AND WALTON, paint makers, of Haltwhistle, Northumberland, and SHERWOOD PAINTS, of Barking, Essex.

Committees on which the new director will serve include the European Committee of Paint and Printing Ink Industries, the Federation of British Industries Grand Council, the FBI Statistics Committee and others within the Paint Manufacturers' Joint Executive Council.

Jubilee Export Conference by BEAMA

THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION'S golden jubilee export conference in London in October is to spend the whole of its second day in discussion groups until the closing speech at mid-day by the BEAMA President, Mr. A. M. Browne.

Lazard Brothers, the General Electric Company, Associated Electrical Industries, the Board of Trade and Crompton Parkinson are among those whose executives are taking part as discussion leaders. The five groups will discuss:

- Finance for Export
- Market Research
- Standards and Practice and Designs for Foreign Markets
- The Changing Pattern of Overseas Trade
- Export Publicity, Advertising and Fairs

The export conference is being held on 5 and 6 October. On the first day the deputy chairman of the Central Electricity Generating Board is to give a paper on Engineering Achievements in the Electrical Industry, which will relate the developments in the United Kingdom to the export trade.

At the conference luncheon the President of the Board of Trade is to speak.

Nigerian Opportunity for Steel Diversifiers

The potential for establishing an iron and steel industry in Nigeria, and the possible market in West Africa for its products, are given detailed coverage in two reports commissioned by the Nigerian Federal Government.

With ample resources and an expanding economy the Nigerian authorities hope to see their ambition of a large scale iron and steel industry taking shape "as soon as possible." They would like to see overseas companies providing not only technical experience and management but also investment resources.

The two reports follow surveys carried out by the West African and marketing development companies of the PRODUCTION ENGINEERING Group with their associates, CAMPBELL, GIFFORD AND MORTON Limited.

Extremely detailed information on local sources of ore, coal, limestone and other raw materials and energy sources for possible operations are listed in the compendium which forms the first report. Detailed evaluation of West African markets for iron and steel products is given in the second part, which also gives a survey of the ferrous scrap position in Nigeria.

The Nigerian Federal Ministry of Commerce and Industry requests companies interested to make their detailed proposals by December. The reports are available from the Commercial Counsellor, Nigeria House, 9 Northumberland Avenue, London, WC2.

Propulsion Machinery for a Survey Ship

Diesel-electric propulsion machinery worth more than £200,000 for a hydrographic survey vessel for the Royal Australian Navy is to be supplied by ENGLISH ELECTRIC Limited. The order was made through the English Electric Company of Australia.

The survey ship, of about 2,300 tons, will be among the most modern of its kind in the world. Carrying a helicopter, it will have the most recent point fixing instruments, small auxiliary boats fitted with echo sounders and a wide range of additional equipment.

The 5,000 shp twin screw machinery will be driven by three 16 cylinder diesel engines of the CSVM type each with a service rating of 1,987 bhp at 800 rpm. The three 1,330 kW main generators are to be arranged in a series-sandwich with two 2,500 shp, 250 rpm, 900 V propulsion motors capable of being controlled on the modified Ward Leonard principle from either the bridge or the engine room.

The three main engines are to be built at the Preston Works, the propulsion generators, motors and control gear at Stafford and the auxiliary machines at Bradford. The English Electric marine department, at Rugby, who are responsible for the contract, will carry out the engineering of the installation.

Two recent high powered diesel-electric installation orders placed with the company recently have been the New Zealand Government Railways ferry (9,000 shp) and the new cable layer for CABLE AND WIRELESS (6,000 shp).

Machine Tool Deliveries Continue to Rise

With new orders coming in to the machine tool manufacturers faster than the deliveries to the customers go out, the total order book for the industry had reached £110 million at the end of March. This compares with £72 million at the close of 1960's first quarter, a period when orders had been running much more swiftly than they have done in the first quarter of this year.

Home Orders Down

New orders received by the machine tool industry during March substantially recovered from the fall of the previous month, though not quite regaining January's level. Orders taken this March were 32 per cent down on those of March, 1960. Home orders declined by more than a third, export orders by about an eighth.

The pace of deliveries continues to increase, deliveries were 19 per cent greater this March than in March, 1960.

Edinburgh Buses Place Large Leyland Order

Some £400,000 worth of bus orders which LEYLAND MOTORS Limited have recently been awarded by United Kingdom operators include one contract valued at £140,000, from Edinburgh Corporation. This order is for a fleet of 50 Leyland Titan PD2A.30 double deck chassis, powered by 125 hp Leyland diesel engines, equipped with synchromesh gearboxes and having vacuum assisted brakes. Bodywork is to be by W. ALEXANDER and Company, of Falkirk. It will incorporate a plastic front designed by the staff at the Edinburgh Corporation Transport Department. The heating equipment and fluorescent lighting will be new to the Edinburgh bus rider.

Repeat orders amounting to almost £200,000 have been placed by Trent Motor Traction, Western Welsh Omnibus and Birkenhead Corporation.

The Apprentice Commercial Executive

Leyland, along with many other expanding companies, are faced with an increasing demand for well trained commercial executives. Their chief accountant and director, Mr. S. Baybutt, has devised a Commercial Apprenticeship Scheme which is being introduced to help meet the need.

Keeping to the company's policy of promotion from within, the scheme aims to give boys training in up to date business and management techniques, fitting them for future senior executive positions at home and overseas. The selection committee would prefer boys to have passed four General Certificate of Education subjects at O level, including English and Mathematics.

Commercial apprentices are first to be given a training spell in most departments of the commercial division, gaining practical experience in many positions, from internal audit and statistics to purchasing and shipping. Specialisation will follow when a satisfactory period has been spent in this way and training will continue until the end of the apprenticeship.

Machine Tool Orders and Deliveries

	Home		Export	
	March, 1961	March, 1960	March, 1961	March, 1960
	£'000	£'000	£'000	£'000
Deliveries during month ..	8,086	6,621	2,566	2,343
Order book at month end	85,493	54,005	24,867	18,388
Net new orders	9,024	14,175	2,645	3,024

Coventry Climax Fire Pump Engine

The famous FW series of engines, better known perhaps for sports/racing cars, sprang originally from a lightweight fire pump.

To most people the name Coventry Climax engine conjures up visions of Grand Prix racing cars and new lap records. In point of fact, the present-day Coventry Climax FW series engine started as a humble but highly successful fire pump, and as such, has been one of the company's principle breadwinners for the past ten years.

The affinity between the fire pump engine and the racing car engine may not be obvious, but it is quite definite. Both must be small in bulk, light in weight, and have a high power-to-weight ratio. Both must be capable of delivering their full power reliably within seconds of starting. Running is unlikely to last longer than a few hours at a time, with long spells of idleness in between. In contrast to many previous Product Profile candidates, both may reasonably look forward to proper maintenance with routine inspection and service throughout their lives; nevertheless, robustness must be inherent.

The city of Coventry is proud to be the home of Coventry Climax Engines Limited. The sales offices are situated in a new block above the newly-built shopping centre, and with their three outlying factories the company employ over 1,000 people. Though nowadays the proportion depending upon engines for their livelihood is relatively small, due to the rapid expansion of the company's fork-lift truck activities, it is the Climax engine that steals the limelight. In fact, the number of engines produced for racing cars is small compared with the number for fire pumps, which do not hit the headlines.

The company was started in Coventry in 1903 by Mr. Pelham Lee, father of the present chairman, under the name of Lee Stroyer, and turned out quality motor cars. Later the firm became known as the Coventry Simplex Company. Soon, however, the firm discontinued cars and, during the First World War, produced military engines and generating sets in large quantities. After the armistice they continued to concentrate on engines, all inheriting the high standard of quality of the Coventry Simplex car.

Between 1920 and 1936, the gradually expanding company turned out engines for quite a large proportion of leading British motor cars, including latterly the Triumph Gloria and the Morgan 4/4. A particularly successful engine was the type SM 750 cc four-cylinder side-valve engine introduced in 1936 for the Swift Motor Company.

By that time a tendency for car firms to undertake manufacture of their own engines was becoming discernible, and the biggest blow to Coventry Climax came when the Swift Motor Company went bankrupt and left them with a large number of SM engines on their hands. The company was thus faced with finding a new outlet for their engines if they were to remain in business; and their choice fell upon the trailer-mounted fire pump.

FIRST FIRE PUMP UNITS

The first units were designed to use the redundant engines and delivered 120 gpm. They quickly became popular, and many thousands were made and sold during the war. As time went on, the range of capacities increased, until units capable of delivering 500 gpm were being produced, and engines were being supplied for automotive, marine and industrial power generation as well as for fire pumps. However, birth of the famous FW, or "featherweight" family of engines—"The fire pump engine that wins motor races"—was yet to come.

In 1950, the British Home Office issued a specification for a fire pump capable of a delivery of 300 gpm; twice that of the wartime units, and yet of less than half the weight. The idea was to invite manufacturers to produce a truly portable fire pump unit, not necessarily trailer mounted, and capable of being lifted by two men. Coventry Climax decided to go all out and produce a suitable unit, little realizing its importance to their future fortunes and the new kind of

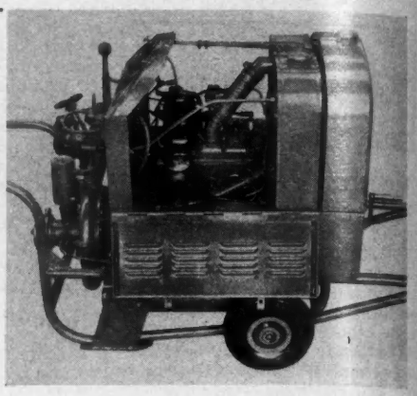


Fig. 1 The FSM, the earliest fire pump

market that it would create. The design of the new engine was based on a conservative estimate of 35 to 40 bhp, at a continuous running speed of 3,500 to 4,000 rpm. Lightness was to be achieved by the very extensive use of aluminium.

The result was a 1,020 cc four-stroke engine having an overhead camshaft and four cylinders in line with dimensions of 2·75 in bore and 2·625 in stroke. The weight of the engine complete was a mere 180 lb, and the complete unit weighed only 330 lb, compared with the 532 lb of its lower duty wartime predecessors.

The FW engine scored an immediate success and resulted in the company securing a steady flow of large Government contracts for it. Apart from its technical superiority a decisive point in its favour was the short time spent in its development. The company were able to go into full-scale production in 1951, only a year after the specification was issued.

The FW engine is generally of aluminium construction and has remained virtually unchanged since its introduction. The cylinder block and crankcase are an integral casting with easily-renewable centrifugally-cast iron liners. The cylinder head, sump and timing covers are also aluminium castings. The wedge-shaped com-

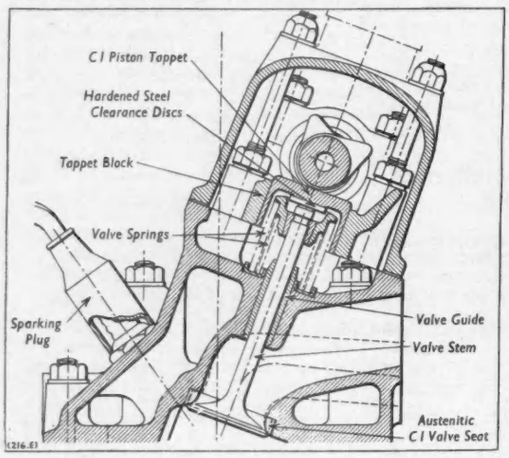


Fig. 2 (above) Single overhead camshaft arrangement.

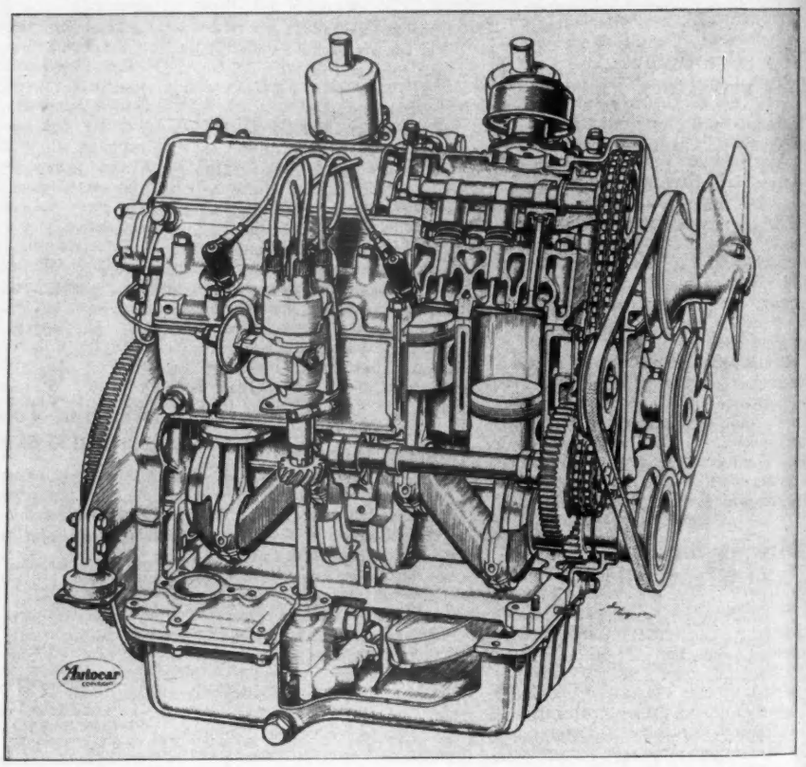


Fig. 3 (right) The ever-popular FWA automobile engine.

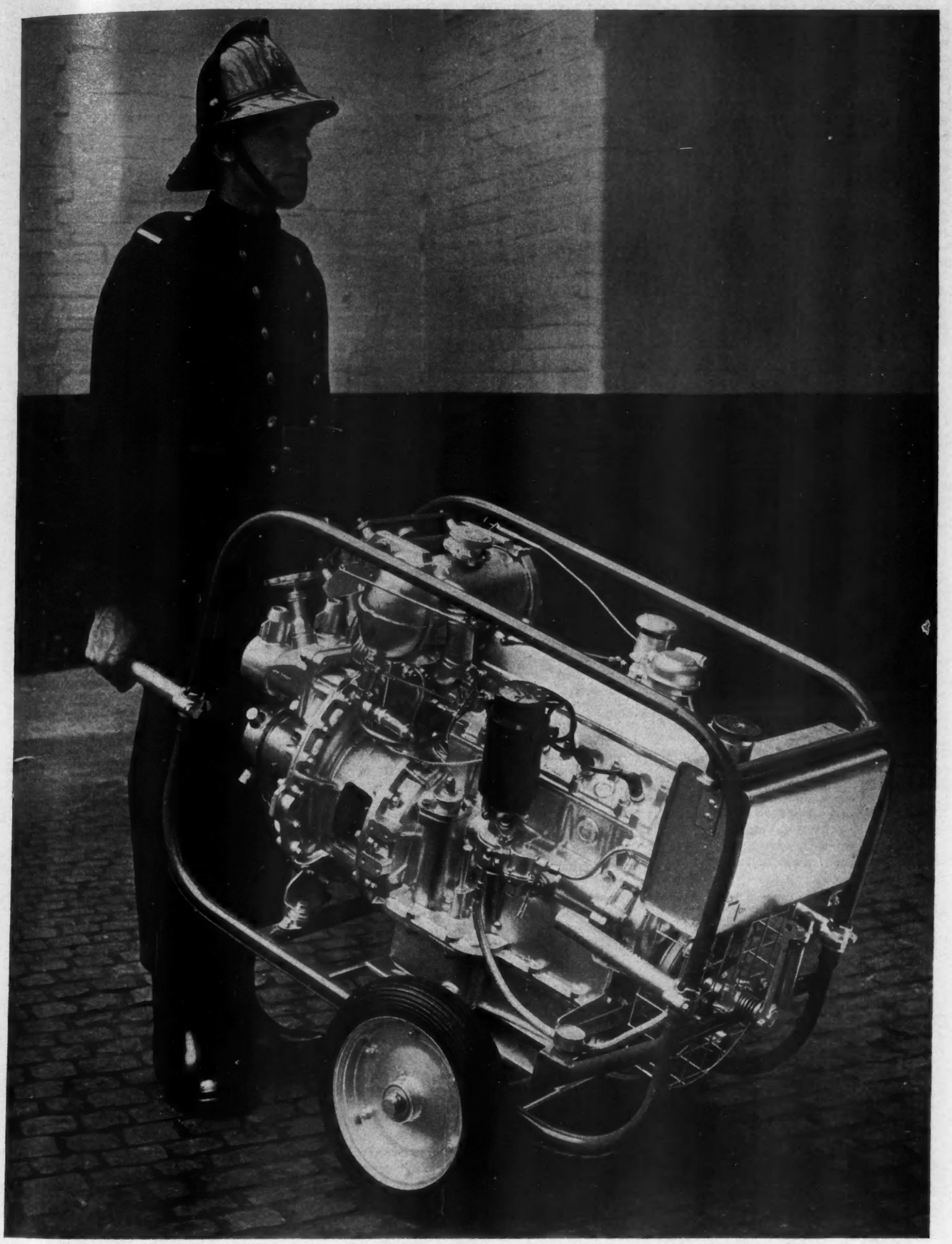


Fig. 4 When the right design is struck first time, its offsprings can aim for a wider market.

bustion chamber and valve port designs were settled as a result of airflow tests. A compression ratio of 7·4 : 1 is employed on the basis of using a regular grade of petrol of about 72 octane rating.

A prime requirement of a fire pump engine is that it must start easily by hand, in either the hot or cold condition. Exhaustive starting tests made in the early days led to the provision of heat-insulating washers between the fuel pump and block, and between the carburettor and manifold. Additionally, the carburettor is protected by shrouding from directly-radiated heat from the exhaust system. Another contributory feature to good starting is the streamlined design of the induction manifold with the sparking plug located directly in the path of the inlet port.

Other features include an extremely robust fully counterbalanced CI crankshaft carried in three plain bearings; aluminium pistons with two compression rings and one slotted oil control ring; light alloy cooling-water pump driven at engine speed; two-stage drive to overhead camshaft with intermediate jackshaft driving the oil pump, magneto and fuel pump; and the valve operating arrangements shown in Fig. 2.

Each cam operates directly on the chill-hardened surface of a CI inverted piston type of tappet working in a CI tappet block. The tappet clearance is adjusted by means of hardened steel discs of graduated thickness sandwiched between the piston tappet and the end of the valve stem. The advantages of this arrangement are the total elimination of side thrust on the valve guide; and the maintenance of correct tappet adjustment over very long periods due to the ample sliding surfaces operating under ideal conditions of alignment.

The crankshaft is drilled to provide end-to-end lubricating oil feed. Each crankpin has a duplicated drilling and is thus fed from the main journal on each side. The connected drillings provide a balanced oil distribution irrespective of slight differences in running clearances in the various bearings.

SUBSEQUENT DEVELOPMENT

Well over 7,000 of the basic FW engines applied to fire pumps and officially designated FWP have been made and sold since 1951. The remainder of the family of engines which now form the FW range have been developed successively from the FWP to meet other specific requirements, primarily automotive; for the new engine was soon noticed and coveted by the motor-racing fraternity.

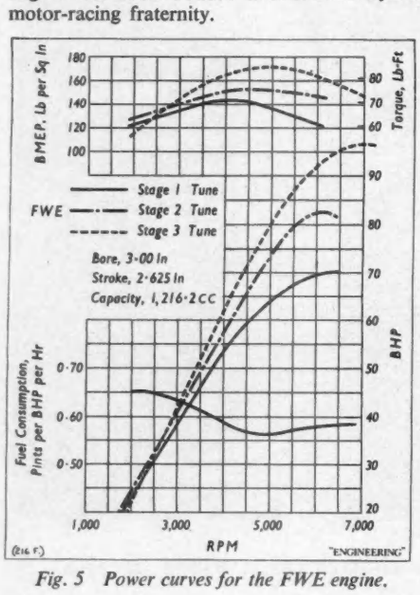


Fig. 5 Power curves for the FWE engine.

FWA Stage I:—The initial modifications included raising the compression ratio, first to 8·4 : 1 and then 9·8 : 1; using a steel crankshaft; fitting twin carburettors; enlarging the valves and ports; and increasing the bore to 2·85 in. Thus the capacity went up to 1,090 cc, bringing the new engine into the 1,100 cc sports car racing class. The Stage 1 was introduced in 1954 and developed 76 bhp at 6,200 rpm. Examples went into a number of sports/racing cars, including the Cooper and Lotus, and several hundreds have been made. Their reputation for high speed and power was matched by their reliability, since they could race for a whole season without overhaul, something quite unknown at that time. They are pleasant to handle on the road and are still in demand today.

FWA Stage II:—To satisfy the insatiable thirst for improved sports/racing car performance, the FWA Stage II appeared in 1956. It was, essentially, a more highly-tuned Stage I engine, with the camshaft modified to increase the opening period and valve lift, and the bhp went up to 84 at 6,900 rpm. A modification made later to the Stage II, and subsequently to all engines, was the substitution of forgings for the cast main bearing caps. It was also found necessary to insulate the carburettors against engine vibration, always a penalty with a four-in-line engine.

FWB:—Before the introduction of Stage III a few engines known as FWB were produced at the request of customers for greater cubic capacity to suit the 1,500 cc class. The nearest Coventry Climax could reach was 1,460 cc, achieved by increasing both the bore and stroke to the extent that the two pairs of end bores had to be siamesed, and the crankcase had to be bulged. With a compression ratio of 11·4:1 a figure of 108 bhp was obtained at 6,400 rpm, but few FWB's were produced for sports cars. In detuned form, however the FWB's found industrial and fire pump uses, and an experimental diesel version was successfully tried.

FWA Stage III:—The Stage III first appeared in 1957; it was designed for a higher engine speed. Using a compression ratio of 10·5: 1 and 100 octane fuel, the power rose to 90 bhp at 7,300 rpm. The Stage III is best known for introducing an improved valve gear to suit the higher engine speed, stronger valve springs being accompanied by a camshaft having five bearings instead of three to resist deflection due to inertia forces. Incidentally, the modified valve gear was also used in two or three short-stroke engines designated FWC, specially made for Lotus to race at Le Mans in the 750 cc class, winning the Index of Performance at the first attempt.

FWE:—In 1957, came the FWE in which the 3 in bore of the FWB was combined with the 2·625 in stroke of the original FW engine, giving a capacity of 1,220 cc. The FWE has a fairly wide range of application, both automotive and industrial. It is used in several types of sports car and in one version of the new Triumph Herald. When built up in racing form with FWA Stage III valve gear and free-flow exhaust system it delivers 96 bhp at 7,250 rpm.

Most of the engines described above are still in production. After the FWE, a further line of development commenced. It had been realized that, due to the advances made to engine design in the intervening years, the 35 bhp necessary for the general-purpose portable pump unit could be obtained from a much smaller engine than the 1,020 cc basic engine. The smaller versions, which start with the FWM of 750 cc capacity, lie outside the scope of this Product Profile, as also does the full motor racing (as opposed to sports car racing) offshoot of the FW, the twin camshaft engines.

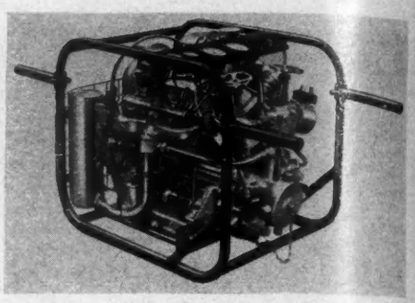


Fig. 6 The latest FWMP lightweight fire pump.

These engines started with the FPE using a V8 arrangement in 1956, and were the result of continual approach from racing car constructors following the success of the single-camshaft FW engines for sports cars. It is the 1½ litre four-cylinder in-line FPF engine around which most of the subsequent racing engine development has been centred. The breakaway between commercial and racing engines, which, for so long, progressed together, has become complete.

In the three years 1958-60, the FPF has been a winner in both its 2½ and 1½ litre forms. Later this year, a new V8 engine is promised; but, in this article, it remains now to consider what the future holds in store for the FW proper.

DIESEL TREND

The gradual trend in favour of diesel power for small units led to trials with a diesel version of the FWB, which gave 45 bhp at 4,500 rpm for a weight of 250 lb. It has never been produced commercially as there are many problems to be solved before a range of inter-available diesel/petrol engines can be made a marketable proposition. The principal constructional differences in the FWD compared with the FWB are a reduction in bore from 3 in to 2·9 in, giving a capacity of 1,320 cc; and a stiffened-up crankcase to suit diesel pressures.

Coventry Climax informed ENGINEERING that the first production diesel, the FWBB, will eventually lead to a family of diesels all based on this engine, and available optionally as petrol engines using the same basic parts. So they will carry a stage further the standardization policy which already characterizes the FW series, in which no less than 80 per cent of the components are standard throughout the range.

The phenomenal success of the original FW range of engines can be attributed firstly, perhaps, to the ability of the company to get the design right first time without incurring a lengthy and expensive period of development before going into production. Speed is essential today if a newly conceived product is not going to be launched too late for its intended market, so rapid are the rates of technological and social advancement. This is particularly true of motor racing, with Formula classifications changing from year to year.

Secondly, Coventry Climax have always succeeded in reconciling two conflicting interests, standardization of the fire pump unit and of individual engine components on the one hand, and attention to individual customer's requirements on the other.

Though the FWP fire pump is still being sold in large quantities all over the world, the smaller FWMP pump with the FWM engine becomes, naturally, increasingly popular. The future of the FW series for fire pump and industrial use now lies in the FWBB; while the constantly developing racing engines will no doubt continue to give an excellent account of themselves.

Combined Research on Plastics and Rubber

To meet the rapidly increasing technological demand of the nation's plastics industry, the former Research Association of British Rubber Manufacturers has extended the scope of its activities in 1961 under the new title of " Rubber and Plastics Research Association of Great Britain."

The new joint research association is a logical move, since the science and technology of these two industries have much in common. The idea has been widely accepted by both industries and has received active support from members of the former Research Association of British Rubber Manufacturers and of the British Plastics Federation. The Department of Scientific and Industrial Research has also welcomed the idea and has agreed to grant the new association up to £77,000, provided that industry itself raises £120,000 in each of the three years 1961 to 1963.

At a recent technical meeting in London, there was a valuable exchange of views between officials of the new research association and representatives of plastics firms. Various proposals were made for future work programmes. These included standardization of test methods; productivity studies, particularly in moulding and fabrication; liaison with other research associations and laboratories on such common problems as toxicity; and a study of plastics rheology, i.e., the science of flow of matter, and the critical study of elasticity, viscosity and plasticity.

The rapidly growing plastics industry in Britain consists of hundreds of firms—embracing some relatively few producers of the raw material who make use of scientific manufacturing methods, and many small and medium sized firms who mould and fabricate various plastics articles.

New laboratories to house plastics research equipment and staff are now being built at the association's headquarters at Shawbery, near Shrewsbury, and will be ready for work in eighteen months. Much of the work at first will be concerned with practical problems of process productivity and technological development. For example, there is no suggestion of entering the field of polymerization. Again on the practical level, it is probable that the research association will buy the more expensive testing machines on which measurements can be made on behalf of individual member firms.

Confidential sponsored work, analyses, and the pooling of information are other ways in which the new association should be able to provide useful services of coordination; and a suggestion for a consumer advice service, which would assess materials on a standard basis on behalf of member firms, has received wide support.

Greater Reliability for Satellites

Having already announced plans to develop an artificial satellite communications system, and to put it into operation as soon as possible, the Bell Telephone Company, USA, are currently investigating methods of prolonging orbital life.

Until now, most satellites have been designed for short-term experiments, but Bell engineers have as their goal the production of satellites which will work dependably for many years. The fact that previous satellites have had such short-lived periods means that there is little data available on the factors affecting life in orbit. However, it is known that among the main hazards will be heavy electronic and protonic bombardment.

To offset the effects of sub-atomic bombardment, Bell engineers propose to face their satellites with pieces of sapphire. These will be placed over the solar cell facets, giving them protection from bombardment and assisting in the dissipation of heat that will arise from prolonged sunlight.

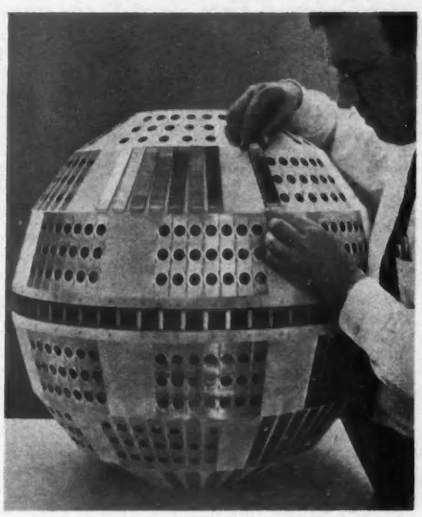
Although costly, the sapphire facings will in fact be cheaper to make than the silicon solar cells that they will protect. But, more important than cost, is the fact that they may enable the satellite's power system to operate for exceptionally long periods.

Two differing sizes of test satellite—with diameters of 27 in and 4 ft—are being considered for experiments. More than half the surface of the small one would be covered by a total of about 4,000 Bell solar cells. The larger satellite would carry about 12,000 cells.

This development work on protective devices is part of a large scale reliability programme, similar to those previously carried out in connection with submarine cables. In such a programme, each component is developed to such a reliability that its individual life is far greater than the goal for the entire system. Components will be tested in simulated environments, containing all known hazards.

Since insufficient data is available on the conditions in space, even the most carefully planned tests in simulated environments cannot be guaranteed. For this reason, Bell Laboratory engineers plan to use their first experimental satellite to take additional measurements of space radiation and to serve as first life-test of new components.

A site for the first launching will be ready early next year. The first test satellite could be ready at the same time, provided the US Government designates a launching vehicle some time in the near future. The Bell company has offered to pay the costs of the rocket and launching.



Transparent coverings of man-made sapphires are placed over the solar cells to protect them from heat and sub-atomic bombardment.

Inhibiting Corrosion of Mild Steel

Several topics related to the inhibition of corrosion are discussed in the current annual report of the National Chemical Laboratory. In particular, the importance of electrode potential to the inhibition of corrosion of immersed mild steel is reported.

Adsorption of anions on the surface of a metal is a likely first step in the inhibition of corrosion. There is considerable evidence of adsorption in acid solutions and it has been suggested, as a result of work with radioactive chromate, that adsorption is also important in neutral solutions.

According to currently held theories, an essential condition for adsorption of anions, and hence for inhibition, is that the electrode potential of the metal should be more positive than that of the electrocapillary maximum, that is, the zero charge potential for the given metal.

Experimental evidence in support of these views has been obtained for mild steel allowed to corrode in chloride solutions to which sodium benzoate was subsequently added. The potential of the steel was poised initially at predetermined values by aeration of the solution. Only when this potential was more positive than a critical value did addition of sodium benzoate result in inhibition, as indicated by a rise in potential to " noble " values.

The onset of inhibition was more rapid when the initial potential was made more positive. Similar results were obtained if the initial potential was raised by anodic polarisation produced by an applied current, provided the sodium benzoate was added slowly. If the benzoate was added quickly, the sudden increase in conductivity of the solution caused the potential to fall below the critical value, so that corrosion was not inhibited. This could be avoided by making the initial potential sufficiently high.

The critical potential for mild steel has been found to vary from 0·26 to 0·43 volt, depending on the surface preparation of the metal and the nature and concentration of the inhibitive anions. This can be explained if the critical potential is determined by the balance in the rates of two opposing processes. The process leading to inhibition is considered to be the adsorption of anions, which takes place at or above the zero charge potential, at a rate increasing with more positive potential and with increasing concentration of anions. The opposing process is the tendency of the steel to corrode, as measured by the initial corrosion rate in fully aerated solutions.

The investigation has provided a possible explanation of the mechanism of inhibition of the corrosion of mild steel in solutions that are in equilibrium with the air but not vigorously aerated. The primary function of oxygen (in solutions of non-oxidising inhibitors) would seem to be to maintain the potential of the specimen above the critical value for a time sufficient to enable the inhibitive anions to become adsorbed.

The presence of air is not necessary in solutions of nitrite or chromate (or other oxidising inhibitors) because these substances can raise the potential sufficiently. It has been found that, if the addition of a non-oxidising inhibitor to steel that is already rusting does not prevent further corrosion, inhibition can often be achieved by vigorous aeration of the solution, particularly if all corrosion product is brushed off the surface of the steel.

Oil Consumption Studies

The BP Research Centre have made use of two techniques in their studies of engine-oil consumption; the first entails statistical analysis of engine tests; the second makes use of specially designed rigs.

IT HAS been found that oil consumption in automotive engines is influenced by lubricating oil viscosity and by engine speed.

Previous studies of oil consumption have usually been done in actual engines but this type of work introduces considerable difficulties due to complexity of running conditions and introduces other problems which adversely affect test repeatability. Oil flow rates past the rings are very sensitive to minute changes in the side and radial clearances of the rings in their grooves. Moreover, oil loss is a small difference between two large flow rates taking place in opposite directions along the cylinder walls. Changes in flow rates are thus liable to be magnified into wide fluctuations in oil loss, the measurement of which, in itself, can be in considerable experimental error.

There are two main ways to circumvent these difficulties. The first involves the use of statistical methods when designing the engine tests and analysing the results so that valid conclusions may be drawn in spite of large variability. The second way is to eliminate the sources of error by simplifying the experimental apparatus until all the variables can be closely controlled. Both approaches have been used in the present study.

Engine and Rig Equipment

A four cylinder 2·2 litre overhead valve engine of conventional design was used for all the engine tests. To enable continuous measurement of oil consumption to be made the engine was converted to a dry sump lubrication system, the oil container being supported on one side of a weighing balance. This method enabled the quantity of oil in the container to be maintained at constant weight, and the oil consumed by the engine was determined by the weight of oil added at regular intervals over a test period of six hours. Provision was also made to enable the supply of oil to the rocker shaft to be interrupted.

In addition to the normal temperature measurements, provision was made to measure the temperature behind the top piston ring on number 4 piston. This was achieved by inserting a thermocouple in the back of the ring groove and leading the wires to a pair of contacts made from the corresponding thermocouple materials mounted on the bottom of the piston skirt. These contacts were arranged to make sliding contact at bottom dead centre with a similar pair of contacts mounted on an air operated plunger fixed to the crankcase (Fig. 1).

The motored rig (Fig. 2) consisted essentially of a test piston reciprocated in its cylinder and accurately located so that only the piston rings contacted the bore. A constant supply of oil was directed through four vertical jets against the piston skirt and that flung clear above the piston was caught on a conical baffle and led away for measurement in a burette. The oil supply and jacket temperatures were maintained at 300° F—the approximate temperature of the oil in the ring belt of a fully warmed-up engine. The pressure in the space above the piston was controlled to simplify the flow conditions.

Speed and Load Effects

A primary route of oil loss is the hydrodynamic film developed between the cylinder and the face of the piston ring. The formation of such a film is not completely understood and is generally accounted for by wear profile, tilting, "thermal wedge," or "squeeze" effects. Film formation conditions are simpler when a taper faced ring is used and, since this ring type is in very common use, it is ideal for studying the effect of operating variables on hydrodynamic film formation. A taper faced ring normally mounted in an engine passes oil predominantly towards the sump. To measure this flow in the rig, where the oil collecting apparatus was above the piston, the ring had to be inverted. An O-ring could be mounted beneath the test ring to prevent axial motion in the groove and eliminate oil flow via this route.

Engine tests were made in which the oil consumption was measured at various combinations of engine speed and load. Sump oil and jacket temperatures were kept constant. These measurements were repeated with the oil feed to the rockers disconnected from the main oil supply. Relationships of the form $\log_{10}Z = a + bx + cy + dx^2 + cy^2 + fxy$ were fitted to the data, where Z was the oil consumption in lb per hr, x was the load expressed as a proportion of full load and y was the engine speed in 1,000 rpm. From these analyses it was apparent that under these test conditions the effect of load was insignificant. The best fit to the data was obtained from linear relationships between speed and the logarithm of the oil consumption.

The final relationships obtained are shown in Fig. 3. The oil consumption was 1·34 times greater with the rocker feed on than with the feed off so that normally about 25 per cent (95 per cent confidence limits, 13 per cent to 36 per cent) of the oil was consumed via the valve guides. The relationships indicated that each 1,000 rpm increase in engine speed increased the oil consumption three times (95 per cent confidence limits were 2·8 to 3·4).

Tests in the motored rig showed that oil flow past the face of a tapered ring also increased with speed, and these results are illustrated in Fig. 4. The rise in speed from 1,000 to 2,000 rpm increased the flow of the three oils tested by just over three times which was in close agreement with the engine tests.

It is known that the formation of a hydrodynamic film is assisted by having high relative velocities between the sliding surfaces. The

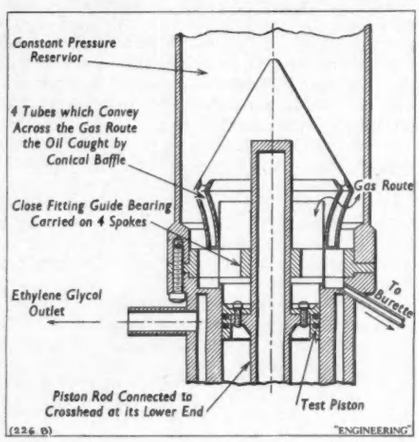

Constant Pressure Reservior
4 Tubes which Convey Across the Gas Route the Oil Caught by Conical Baffle
Close Fitting Guide Bearing Carried on 4 Spokes
Ethylene Glycol Outlet
Gas Route
To Burette
Piston Rod Connected to Crosshead at its Lower End
Test Piston
(226 9)
"ENGINEERING"

Fig. 1 (Right) Piston and plunger.

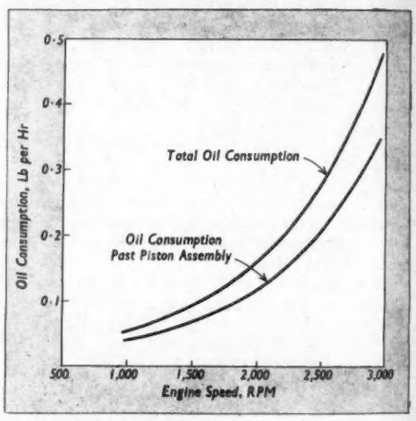


Fig. 2 (Above) Details of test rig.

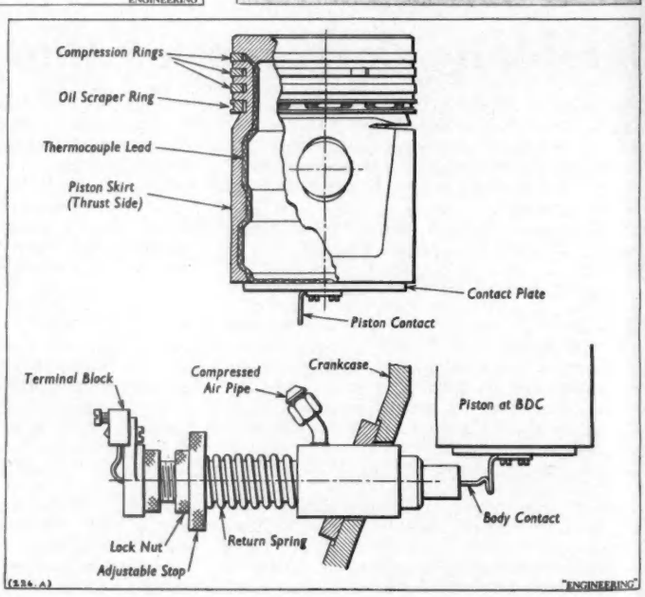


Fig. 3 (Above, right) Effect of speed on oil consumption.

Research Report

on work of the

Petroleum Division
British Petroleum Research Centre
Sunbury-on-Thames
Middlesex.

Manager
E. S. SELLERS, M.A., M.I.Chem.E.

Research Team
J. C. CREE, F.Inst.Pet.
R. V. HOBBS, G.I.Mech.E.
W. C. PIKE, M.Sc.

classical Reynolds equation was solved for the conditions prevailing and the theoretical increase in oil flow rate with speed was predicted. The variation with speed depended on whether the ring was operating near certain optimum conditions which are described later. At these conditions theory predicted that flow rate would increase as (speed)$^{3/2}$ which was in fair agreement with both rig and engine tests. To the extent that nominally square faced top rings, due to wear, tilting, etc., allow similar oil film formation, the results can account for the effect of speed on oil loss in an engine. These rings would allow oil to flow upwards past their faces at a higher rate as the engine speed rose and a proportion of this oil would be lost before the next upstroke.

Oil Viscosity

It is generally known that oil viscosity will influence oil consumption. In an engine, viscosity is affected by both water jacket and oil temperatures and it was considered worthwhile to obtain information on the relationship between the working oil viscosity and oil consumption.

A statistical programme of 42 six hour consumption tests was conducted using three oil viscosity grades (SAE 10 W, 30 and 50) and oil and jacket temperatures as the controlled variables.

The oil temperature in the ring belt is much higher than that of the oil supplied to the bearings. It was considered that viscosities in both these regions would influence oil consumption and so the appropriate temperatures were measured during this programme and a relationship was obtained between oil consumption and the oil gallery and ring belt viscosities. This relationship was of the form

$$\text{Log } Z = a\,V_1 + b\,V_2 + K.$$

where Z = oil consumption, lb per hr
V_1 = ring belt viscosity, c S
V_2 = gallery viscosity, c S

and is shown graphically in Fig. 5.

The figure indicates that oil consumption rapidly increases with a reduction in viscosity in the ring belt area. However, oil consumption is shown to decrease slightly with a reduction in oil viscosity at the oil gallery zone. The reason for this is not fully understood although it may be related to the extra piston cooling effect associated with the higher supply rates of the lower viscosity oils.

This series of engine tests indicated that oil viscosity in the ring belt area had a major influence on engine oil consumption and that gallery oil viscosity had only a minor effect. In practice, where oils are considered in terms of their SAE viscosity classifications, the analysis showed that a change from SAE 30 to SAE 10W increased consumption by 98 per cent whereas a change to SAE 50 only decreased consumption by 6 per cent. The reasons for the viscosity sensitivity of the engine became clearer when individual oil loss mechanisms were studied in the rig.

The effect of viscosity on flow past a taper faced ring is seen in Fig. 4. The marked increase in flow as the viscosity was raised was due to the thicker films developed with the more viscous oils. Hydrodynamic theory predicted that, at optimum conditions, flow would increase as the square root of the viscosity.

Rig tests with other piston and ring assemblies were also made. In one, the ring pressure was deliberately kept very high to minimise flow via the ring face. No O-ring was fitted so that oil was free to flow behind the ring and through the ring gap. Oil loss was then found to decrease as the viscosity was raised.

Previous work had shown that a deep top piston land with a small cylinder-piston clearance could assist in reducing oil consumption. Further tests showed that this beneficial effect was increased by raising the oil viscosity.

The engine tests had shown that oil loss was decreased by raising the viscosity. Therefore it was evident that the reduction in flow round the backs of the rings and the more effective oil retention in the top land clearance as the viscosity was raised had more than offset any increase in flow past the faces of the rings. In ring arrangements relying on high rates of "downpassing" past ring faces—e.g. taper faced or internally stepped rings—the decrease in consumption with increasing viscosity would be still more marked. To investigate this effect further, taper faced ring performance was examined in more detail, both experimentally and theoretically.

Ring Taper

It followed from the solution to the Reynolds equation that V, the flow rate per unit circumference of a tapered ring, could be expressed as

$$V = U\,l\sqrt{\frac{6\,\eta\,U}{P_0}} \times F_\varphi$$

where U was the sliding velocity
l the axial ring width
η the absolute viscosity of the ring belt oil
P_0 the radial pressure exerted by the ring per unit circumference.

F_φ was a function of the above variables and depended also on the angle of the ring taper, the amount the ring was worn and the pressure applied at the leading edge of the ring. For the unworn, unpressurised ring F_φ became a maximum when the taper angle α was given by

$$\alpha = 0{\cdot}32\sqrt{\frac{6\,\eta\,U}{P_0}}$$

This optimum angle increased as the wear flat extended across the face of the ring. It was reduced by the application of pressure. In practice, a ring having the optimum angle under unworn, unpressurised conditions would be expected to give close to the maximum possible flow rate throughout its life in an engine. In theory, such a ring with a flat worn halfway across its face would retain about 75 per cent of its unworn flow rate and even with 9/10ths of its face flattened the flow rate would still be about 33 per cent of the unworn rate.

As ring taper, once fixed, is a constant, optimum conditions can only occur at one speed. Because sliding speed varies throughout the stroke and because engine speed may vary widely, an investigation was made to obtain the best value of "design velocity," U, to put in the above equation. It was found that, for a given engine speed, the maximum total oil flow per stroke was obtained when design velocity was very slightly less than the maximum piston speed. If design was based on the maximum piston speed at 1,500 rpm then the flow rates, as they increased through the range 1,000-6,000 rpm would be within 5 per cent of their maximum values; it was evident that this design velocity was close to the value giving best overall performance.

Some rig tests were made with rings of varying taper angle. The results appear in Fig. 6 and show that the existence of an optimum angle was confirmed although at a rather coarser angle than that predicted by the above equation.

Conclusions

The statistical analysis of the engine test results demonstrated the responses of oil consumption to engine speed and oil viscosity. The rig tests suggested mechanisms which could account for these results. Increased hydrodynamic flow was a cause of high speed oil loss. With the thicker oils, restricted flow along routes other than the hydrodynamic film resulted in reduced consumption; this effect more than offset the increased flow via the thicker hydrodynamic films. Most use could be made of the "downpassing" property of a taper faced ring if it was designed to operate at certain defined optimum conditions.

The experimental work described in this report was carried out at the Cambridge University Engineering Laboratory, under the direction of Dr. P. Dykes, and at the BP Research Centre.

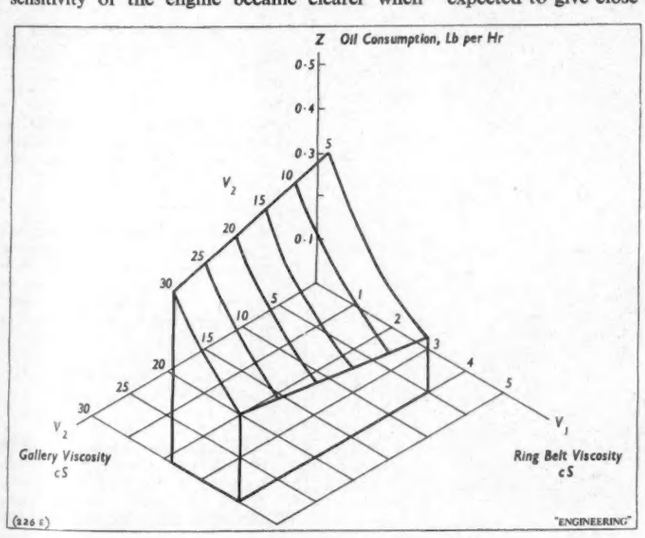
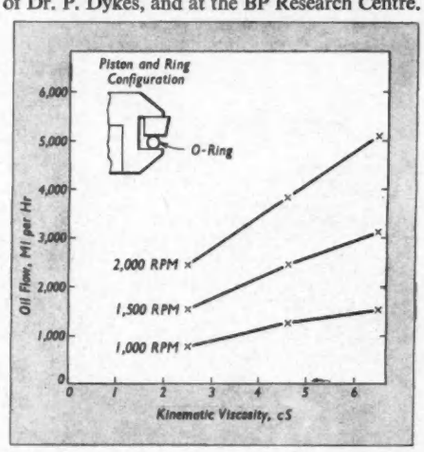


Fig. 5 (Left) Effect of ring belt and oil gallery viscosity on oil consumption.



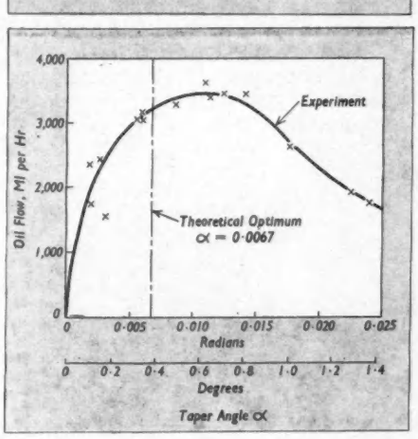


Fig. 4 (Above, right) Effect of speed and viscosity on flow past a taper faced ring mounted in the test rig.

Fig. 6 (Right) Variation of flow rate with taper angle (SAE 30 oil at 300° F)—1,500 rpm.

Power Aids from Abroad

EVERY gadget that reduces the amount of work people have to do is criticised as making them lazy. "Always want something to do it for you" is the cry of the older generation. But the plain facts are that labour is at a premium and that in households where both husband and wife go out to work time is an even more vital commodity. Besides, some gadgets do the job far better than most people can by hand.

If you have a great many cans to open, a power tool is an obvious saving, and one that avoids having to shift all the cans to the tool and then away again—in other words a portable model—is also saving in labour and fatigue. Such a one is the Edlund, shown in the first illustration, and being distributed in this country by Medcalfe and Company (1950) Limited, of 141-142 Saffron Hill, London, EC1.

The Edlund machine will open from 500 to 750 cans per hour depending on the arrangements. A particular claim is that clean edges are left on every can. It is light—it weighs no more than a large size tin—and will operate from standard mains supplies. Since the motor is universal either alternating or direct current can be used. The tins can be opened equally well whether they are standing in a line or still grouped in the packing case. All sizes can be handled from sardine tins to the largest normally encountered. The motor housing, opener assembly and handle are die cast aluminium while both the cutting wheel and drive gear are tool steel for smooth cutting and long life. Control is by an on-off trigger and there is a bracket for hanging the tool up after use.

Clothes and upholstery can be vacuum cleaned by the electric hand brush shown in the last illustration. This is the Peugeot Airbrosse imported into this country by Rudson Wood and Company Limited, 6 Kilburn High Road, London NW6. Streamlined with a plastic handle and casing, the Airbrosse has a dust collecting chamber built into the body, so that there is no hanging bag to get in the way. The chamber is emptied through two sliding panels at the sides.

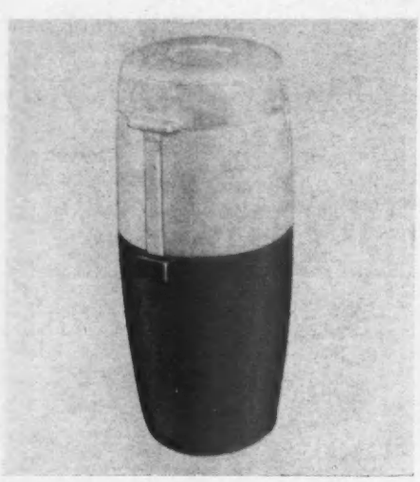
The vacuum fan is driven by a universal motor rated for 200-250 volts which is free from radio interference. Control is by a push button switch on the handle. The bristles are set in three shaped rows around the air suction intake so as to enable the brush to reach most parts of the fabric. For folds, ruffles and chair corners there is a special nozzle attachment to give the increased reach. Being light to hold the Airbrosse is easy to use and the fact that it is a vacuum eliminates any flying dust.

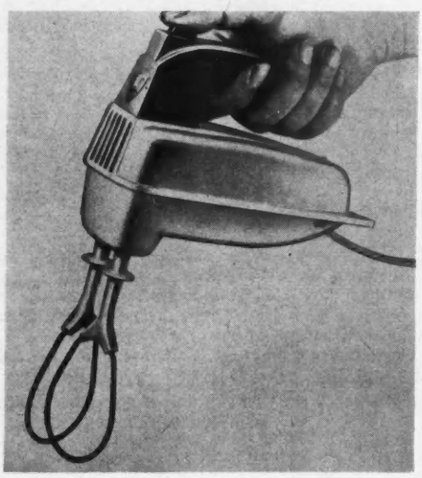
The upper right illustration shows the Squirrel food mixer-also made by Peugeot and imported by Rudson Wood. It is a low price machine for general mixing work and has only two attachments—one for light and the other for heavy mixes. In addition a chromium glass mixing bowl is available. The body of the mixer is made in white plastic designed for easy cleaning and the whisks are stainless steel. Control is by a two position switch which allows of intermittent or continuous mixing. The interference-free universal motor is intended for normal 200-250 volt mains; it runs at 1,500 rpm and has a consumption of 110 watts.

From Norway comes the fourth item, a coffee grinder. The case is flask shaped with a transparent top through which the progress of the grinding can be observed. The motor is started by pressing a button and grinding continues as long as the button is pressed. The process is very quick and there is a safety interlock that prevents the motor from starting until the lid is on. Consumption is 170 watts and the motor runs at 24,000 rpm. The unit is double insulated so no earth connection is required. Norel Electrical Appliances Limited, 187 Hammersmith Road, London W6, are the importers.

(*Above*) *Power makes light work of can opening when there are many to do.*

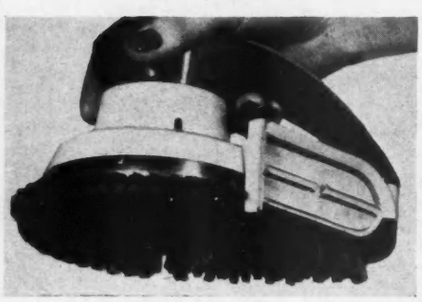
(*Below*) *Coffee grinding is fast in this power driven unit with its transparent cover.*





(*Above*) *Mixing can be continuous or intermittent.*

(*Below*) *A vacuum brush cleans clothes and fabrics.*



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